VOLUME 85, No. 7

STEAM GENERATION
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A McGRAW-HILL PUBLICATION

Publication office: 99-129 North Broadway, Albany, N. Y.
Editorial & Executive Offices: 330 West 42nd St., New York, N. Y.

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LONDON, Aldwych House, Aldwych, London, W C.2

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POWER articles are currently indexed in both the Industrial Arts and the Engineering Indexes, available at public libraries. Also every year POWER issues an annual index of its own. Cable Address: "McGraw-Hill, N. Y."

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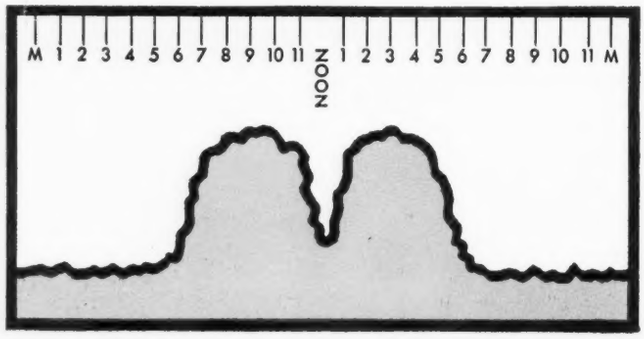
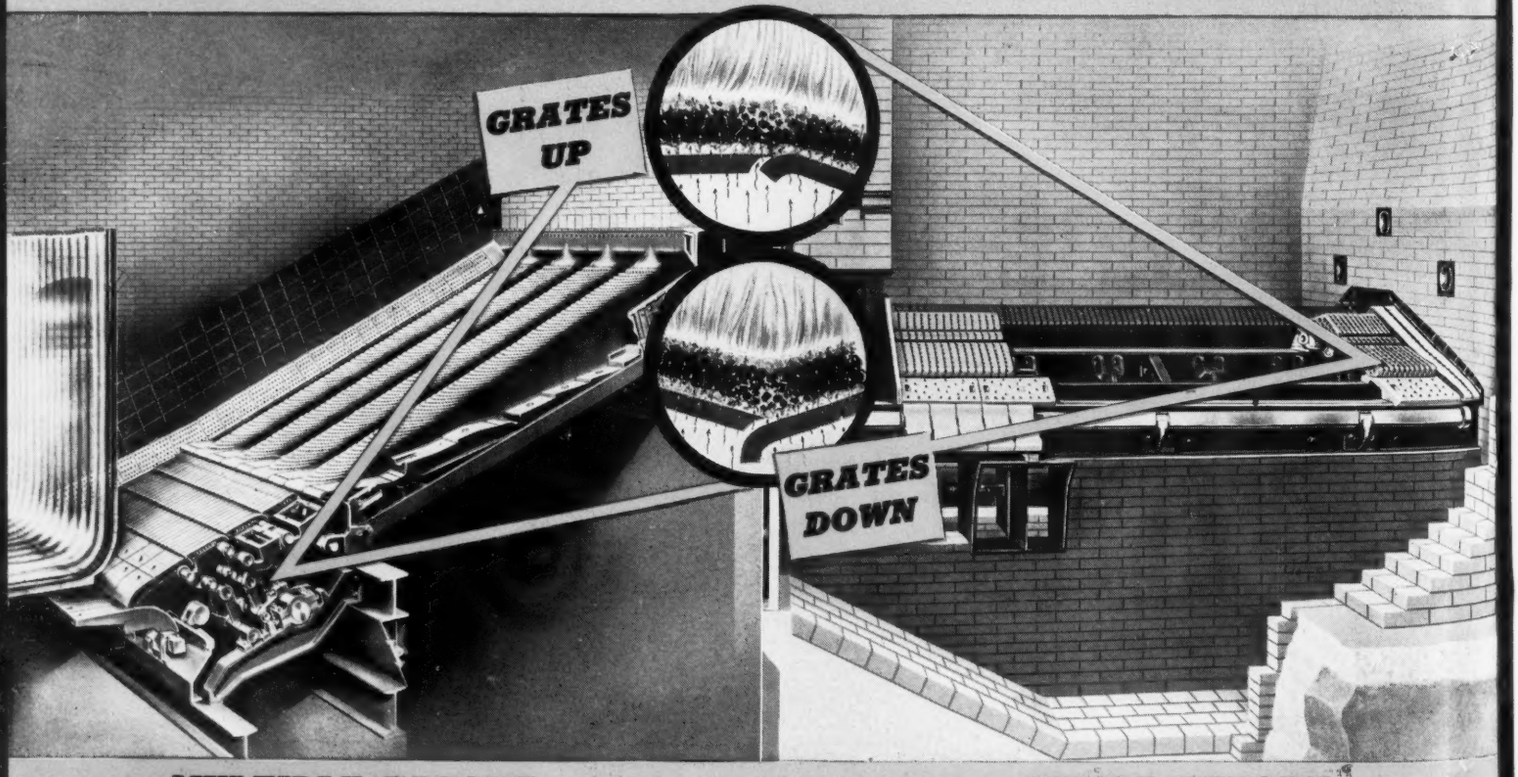


Daily boiler load curve of a typical industrial plant.

Link-Grate STOKERS COVER A COMPLETE RANGE FROM 150 HP UP



MULTIPLE RETORT **SINGLE RETORT**

Westinghouse

POWER

Established 1882 • PHILIP W SWAIN, Editor

Let's Be Proud

American opinion is still divided on the subject of "intervention," but patriots are of a single mind on *defense*. Not one denies that America must produce war materials with unprecedented speed and in quantities never before dreamed of. Every man's mind says yes to this proposition. The time has now arrived for him to say yes with his body, for defense is still little more than tea-table gossip to most of us.

While we talk about our all-out effort, tens of millions of man-hours are lost in criminal strikes and in bickerings for the petty advantage of this group or that. We hear a lot about sacrifices to protect those American liberties that "are dearer than life." Meanwhile more people are employed at better wages, business profits have gone up and taxes haven't taken away the gains—not yet. Is this sacrifice? Not by a single slice of butter.

If sacrifices will come (and they will) let's take our share of them now, lest we grow flabby. If big taxes must come eventually, let's have them early to take away for defense any excess of wages and profits before we can waste them on unaccustomed luxuries. If shortages of this or that commodity are foreseen for 1942, let's pull in our belts right now to ease the future shortage and build up our national gumption. If longer work hours, or fewer automobiles, or less gasoline, must be our eventual lot, let's get going and have it over with.

The simple fact is that the whole 130 million of us are "selective trainees" and most of us are mighty soft, so we have a double job to do. One is to turn out defense materials at top speed. The other is to harden ourselves physically and morally for a long, tough pull. If we would hope to survive and prosper in a world where international gangsters are gifted with brains and iron will we must work some of the fat off of our bodies and out of our heads.

Let us bare our shoulders to the burden of defense and seek no sympathy. Throughout history men of the right fibre have found joy in hard-won achievement—in climbing the high mountain, winning the swift race, fighting the sea.

Now our turn has come. We had thought we were living in an age of high civilization—many of us marked for a life of luxury. It was just a dream; instead we stand in one of the great hard moments of history—in tough times made for tough men. Let's face this fact. Let's sweat and be proud of the chance to do a man's work.

Burlington Station Adds 100,000-Kw

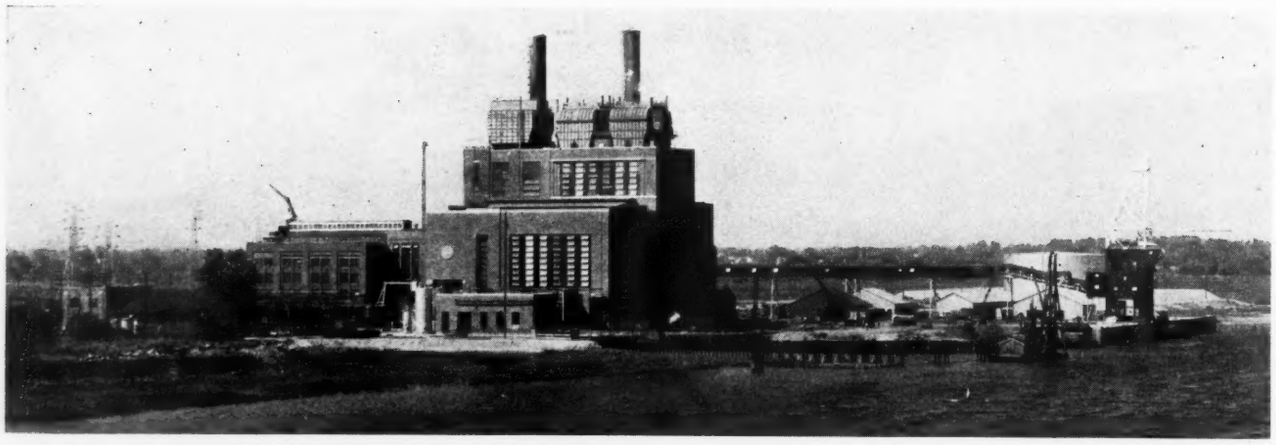


Fig. 1—Fifteen miles from Trenton on the Delaware, Burlington supplies the southern division of the Public Service system

POWER editors asked several central-station engineers which of the many new plants and extensions they would select for design representing stable trends for the future. First on nearly every list was Burlington where a cross-compound, 3600-rpm turbine is supplied at 1250 lb, 950 F by two radiant boilers. Results of several months' operation have shown the value of improved construction details derived from experience at Essex Generating Station

By H WEISBERG
Mechanical Engineer, Electrical Engineering Department
Public Service Electric and Gas Company, New Jersey

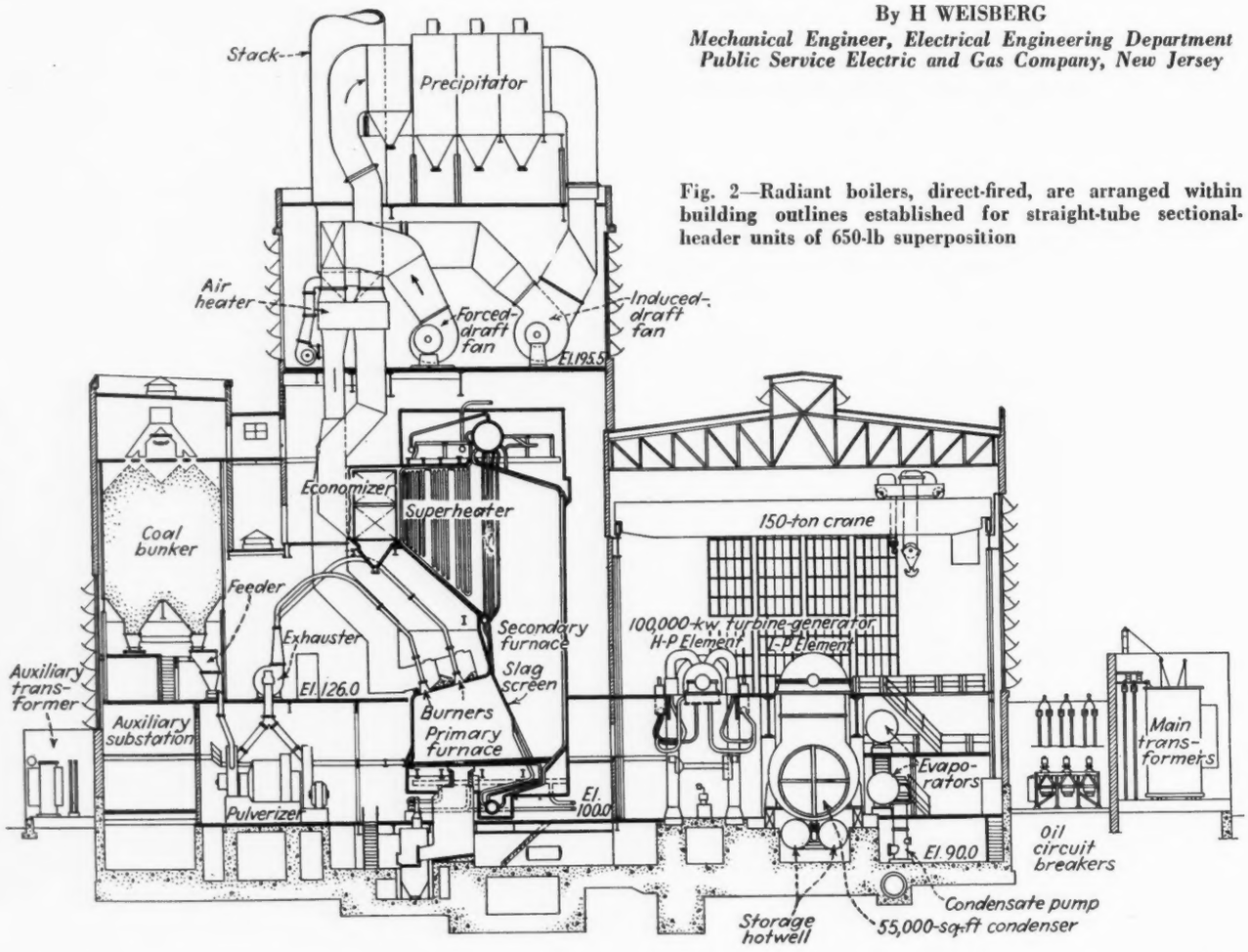


Fig. 2—Radiant boilers, direct-fired, are arranged within building outlines established for straight-tube sectional-header units of 650-lb superposition

Condensing Unit

▶ During October, 1940, a 100,000-kw condensing turbine-generator and two 550,000-lb-per-hr boilers were placed in operation at the Burlington Generating Station of the Public Service Electric and Gas Company, New Jersey. Construction work on a second unit of the same size is now in progress at Burlington; a similar unit and two boilers are being installed at the Company's Marion Generating Station. The fundamental design features of the turbines and boilers follow along the lines developed for the superposed unit installed at Essex Generating Station in 1938 and described in January, 1939, Power. Arrangement of equipment, however, has been altered to suit local conditions, and minor changes have been incorporated as a result of operating experience at Essex.

After installation of the Essex unit, the Public Service System capacity totaled 737,000 kw. Load predictions in December, 1938, indicated that additional capacity might be required in 1941 and possibly 1940. Inasmuch as equipment deliveries at that time meant a construction period of about two years, the new unit was authorized. The Burlington location was chosen as a step towards decentralization of the power supply which prior to this installation had been concentrated in the Meadows Stations (Kearny, Essex, and Marion), and also to take care of the rapidly expanding load in the southern section of the State. Experience with a 90,000-kw machine at Kearny, expected load growth and economic considerations resulted in selection of a 100,000-kw unit.

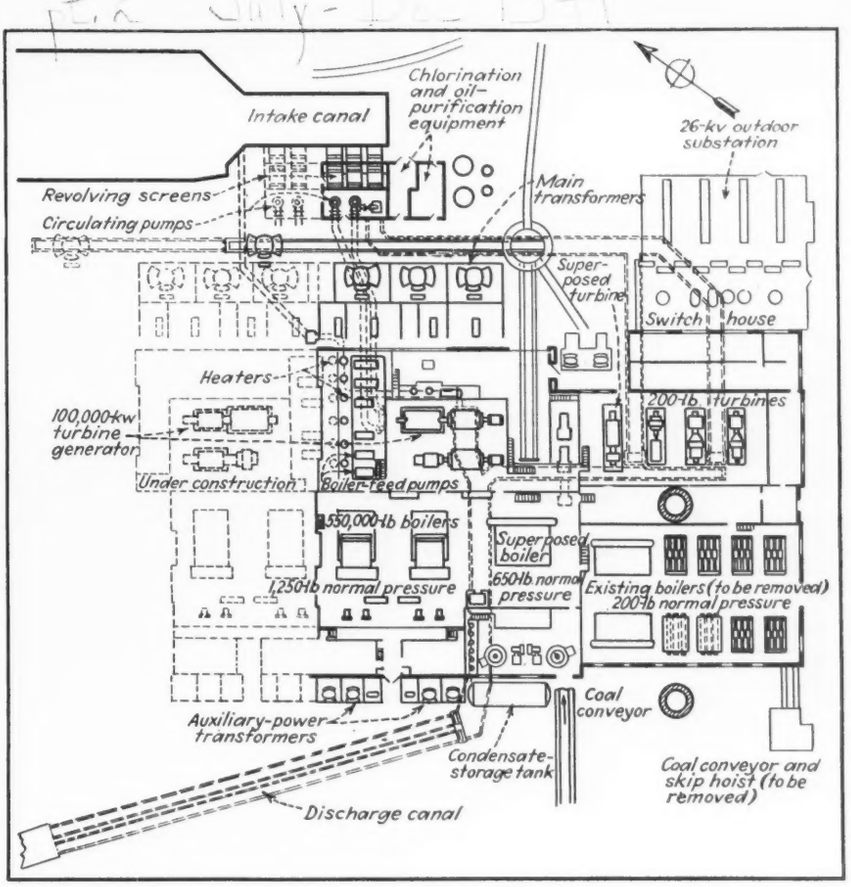


Fig. 3—Station being extended toward river. Condenser circulating pumps located in screen house on intake canal. Transformers outdoors adjacent to turbine room

Steam conditions for the new turbine-generator are 1250 lb, 950 F. Prior to this installation the Burlington Generating Station consisted of a 650-lb, 850-F, 18,000-kw turbine-generator superposed on three 200-lb units, totaling 37,000 kw, or a combined station capacity of 55,000 kw. A single boiler supplied steam to the superposed turbine. Ten 200-lb boilers served as standby for the low-pressure turbines.

Studies indicated that for the 100,000-kw size with expected fuel prices, steam conditions of 1250 lb, 950 F at the turbine throttle showed an adequate return on the additional investment required over the 650-lb, 850-F steam conditions of the preceding Burlington installation. Equipment for this higher steam pressure and temperature had been developed for Essex and, inasmuch as the capacity of the proposed extension was considerably greater than that of the existing station, the higher steam conditions were selected.

The original section of the station, completed in 1914, was superposed in 1932, and at that time the location and cross-section of the present extension was established. (Fig. 1 external view of station; Fig. 2 cross-section of station; Fig. 3 plan of station. It was contemplated that the 650-lb superposed boiler would be followed shortly by a number of similar boiler units serving 60,000-kw condensing turbine-generators. Business conditions, however, considerably delayed the program, and several rather important changes were made in this plan.

In the first place the increased steam pressure and temperature required a radically different boiler from the original superposed boiler, a straight-tube sectional-header unit. The size of the turbine was increased from 60,000 to 100,000 kw. As a result of advance in the art, direct firing of pulverized fuel was considered satisfactory, whereas the storage system had been installed on the first boiler. It was found more economical to locate the screen house and condenser circulating pumps on the intake canal separate from turbine room.

In order to provide better flood protection it was decided to keep all electrical equipment and wiring approximately 5 ft above the highest recorded river level, whereas previously some of the important electrical equipment had been in the basement below normal river level. This was accomplished without excessive pumping lifts by using vertical pumps for such services as circulating water, condensate and fuel oil. In many ways, nevertheless, as in the provision of separate boiler and turbine rooms, enclosed fan room and in general arrangement, the extension follows the 1931 layout.

With addition of the second 100,000-kw unit the ten 200-lb boilers are to be removed along with the two brick stacks, and this portion of the building will be converted to a service building including shops, store room, locker and wash rooms, restaurant and storage space for yard equipment.

The turbine-generator (Fig. 4) is a cross-compound machine with a cross-over pressure of approximately 100 lb g, resulting in high- and low-pressure elements (Figs. 5 and 6) of equal size, 50,000 kw each (normal rating). Both elements operate at 3600 rpm and the

generators are interchangeable. With this arrangement the high-pressure element is practically a duplicate of the 50,000-kw superposed machine at Essex. Two double-flow turbines in tandem make up the low-pressure element. Each double-flow turbine is similar to the low-pressure end of a 50,000-kw, 1250-lb, 3600-rpm condensing turbine, many of which have been built in recent years. While the arrangement of the unit is somewhat novel, the parts which go to make up the whole have all been used quite generally before, and their satisfactory performance has been demonstrated in actual service.

Each element may be operated separately. The new low-pressure element can be supplied with steam from the 200-lb station header through a separate control valve, gate valves in the cross-over piping between elements being closed. The 200-lb steam system is supplied from either the 1250-lb or 650-lb boilers through pressure-reducing (Fig. 7) and desuperheating valves. Also, the high-pressure element may operate separately up to a maximum output of approximately 25,000 kw by exhausting into the 200-lb sysytem supplying the three 200-lb turbines, see Fig. 8.

Normally the high- and low-pressure elements operate together as a compound unit and are tied solidly together on the electrical end with hand-operated disconnecting switches for separate operation which may be opened only while the unit is off the line, Fig. 9.

As in the case of Essex, the high-pressure turbine element is a double-shell, impulse-type machine, but on account of the lower backpressure (100 instead of 225 lb) it has 14 stages instead of 12. Steam is admitted through six control valves, arranged in two chests of three valves each, separate from and on either side of the turbine. The cross-over piping between the high- and low-pressure elements is below the turbine floor, passing through the condenser steam space into the bottom of the two double-flow turbines. Shut-off and intercepting valves are provided in this cross-over piping. Instead of the usual atmospheric relief valve and stack, a low-vacuum throttle trip is used. As a secondary precaution four relief diaphragms in the turbine exhaust casing will rupture in case of positive pressure in the condenser.

A common hydrogen system cools both generator elements. The arrangement is such that one element may be operating in hydrogen while the other is scavenged and opened for inspection; or one element may run in hydrogen while the other is run in air.

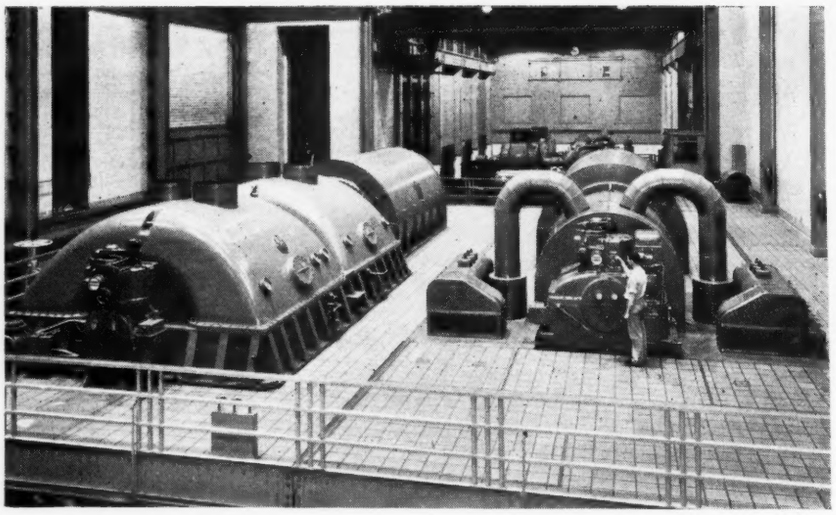


Fig. 4—Cross-compound 3600-rpm turbine in the foreground has two duplicate 50,000-kw generators. Superposed and low-pressure turbines in background

In the generator design special precautions were taken to minimize double-frequency vibration. Thickness of the stator cores was materially increased as compared to Essex. Vibration is approximately one half that experienced at Essex, and runs approximately 1¼ mills maximum.

Each generator element has its own shaft-end main and pilot exciter driven through a reduction gear at approximately half generator speed. Exciters are totally enclosed, air cooled with cooler and filter.

The generator has a normal rating of 100,000 kw, 80% power factor, when running in hydrogen at 0.5 lb pressure. With a hydrogen pressure of 15 lb the rating is 125,000 kw, 87.5% power factor. These ratings are for summer conditions with generator cooling water at 86 F. Equipment for the higher hydrogen pressure is now being installed. The compound turbine is designed to carry 125,000 kw and the unit has actually carried 126,000 kw, 80% power factor with 40-F cooling water.

Blade paths are proportioned so that the load on the two elements will equalize at 125,000 kw; the division at 100,000 kw is approximately 54,000 and 46,000 kw on the high- and low-pressure elements respectively. Best economy point is at approximately 100,000 kw, at which loading four of the six valves are open. The remaining two valves open simultaneously to carry the overload, steam from them bypassing the first two stages.

The condenser is a single-pass, radial-flow 55,000-sq-ft surface unit. With the quadruple-flow low-pressure element it was found desirable to place the condenser parallel to the axis of the machine, using 30-ft tubes. There are 8070 ⅞-in. OD No. 18 BWG Admiralty-metal tubes rolled into Muntz-metal tube sheets. Differences in expansion between the shell and tubes are taken care of by upward bowing of the tubes. The water boxes are divided and the inlet box has a motor-operated division valve in the division wall.

The shell is steel, strength-welded to the turbine exhaust and partly supported by springs. At the center of the bottom of the shell a pin-and-socket guide prevents all but vertical movement at that point. The purpose of this is to relieve the turbine exhaust connection of moments caused by the reaction of the water pressure at the expansion joints in the circulating-water system.

A 10,000-gal deaerating storage hotwell, consisting of two cylindrical tanks, separate from the condenser shell, is directly under the condenser. Condensate from the condenser shell flows through a pipe to a long trough in the top of each hotwell tank. As the hotwell is vented to the point of lowest pressure in the condenser, the water spills over the edge of the trough, boils and is deaerated.

Two 43,000-gpm, motor-driven, circulating-water pumps are located in the screen house approximately 130 ft from the condenser. The vertical-shaft propeller pumps operate at 590 rpm.

Two conventional steam-jet air pumps remove air and non-condensible vapors, one using condensate and the other using river water for condensing the ejector steam. Each unit is capable of removing the total normal air leakage into the condenser at maximum vacuum.

Indications are that steam flow to the condenser is unusually well distributed, and under winter conditions which have prevailed to the time of this

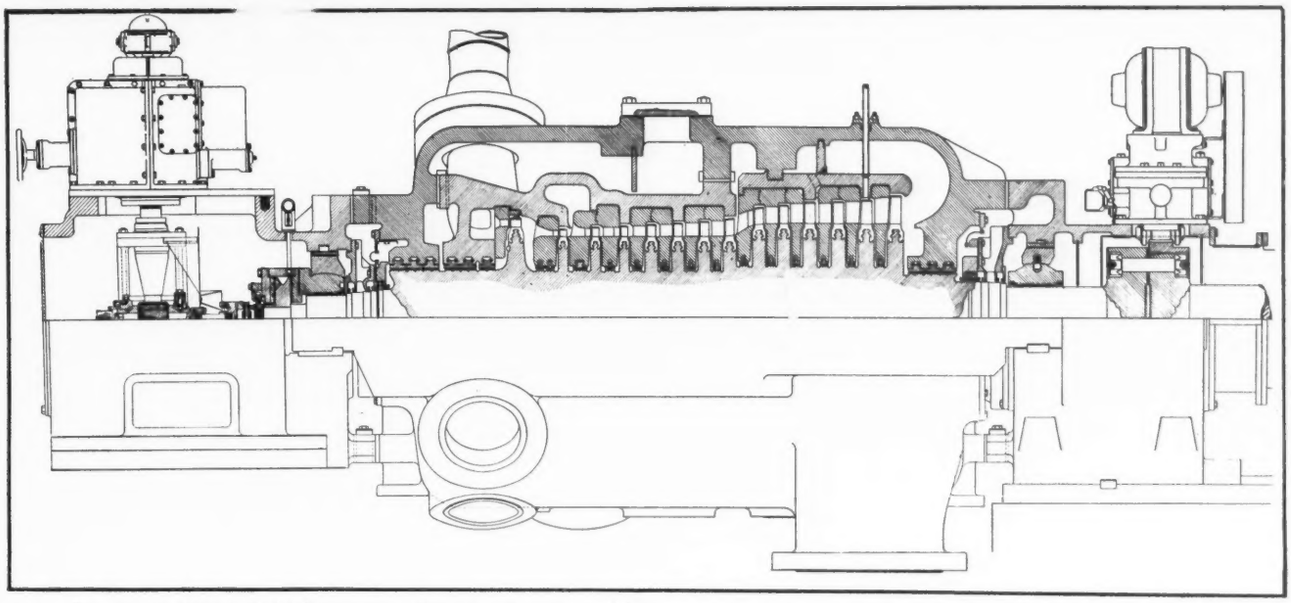


Fig. 5—Double-shell high-pressure element exhausts at 100 lb, can serve as superposed unit over l-p station at part load

writing the vacuum has been better than expected. Only one pump has been required at full load, whereas it had been expected that it would prove economical to run both pumps.

The feedwater-heating cycle is 5-stage regenerative, with two extractions from the high-pressure turbine element, one from the crossover and two from the low-pressure element (see Fig. 10). Two evaporators, arranged to operate either single or double effect, are supplied from the cross-over connection and the vapor is condensed in the next lowest bleeder heater. Heater condensate is cascaded to successively lower-pressure heaters, and finally through a separate drain cooler to the condenser for deaeration.

A feature of the installation is the vertical mounting of all heaters with feedwater heads down, which permits lifting the shell without disturbing the feedwater connections (Fig. 11). All units are closed-surface type with straight tubes, floating heads. Three of the heaters contain counter-flow internal drain-cooler sections.

A condensate pump removes deaerated water from the condenser storage hotwell and discharges through the low-pressure drain cooler and heater to the suction of a primary boiler-feed pump, and then directly to three secondary feed pumps. These latter pumps, operating in parallel, discharge through the four high-pressure feedwater heaters to the boilers. Selection of pumping equipment contemplated the operation of one condensate pump, one primary pump, and two secondary pumps with 100,000-kw load on the main unit, and three secondary pumps with 125,000-kw load.

Constant-speed motors drive the condensate and secondary pumps; the primary pumps are variable-speed with hydraulic couplings between constant-speed motors and pumps. Speed of the primary pump is regulated to maintain constant pressure drop across the water-level-regulating valve at the boiler over a wide range of load variation. Over the remaining range of operation the water-level-regulating valve throttles the excess pressure. At light loads the system operates with primary pump idle.

A fourth secondary pump, with steam-turbine drive, serves as standby in case of complete loss of power for auxiliaries.

Two boilers with convection superheaters, economizers, and Ljungstrom air heaters (Fig. 3), are designed for a steam output of 550,000 lb per hr at a pressure of 1350 lb per sq in. and a temperature of 950 F at the superheater outlet. Notable is the arrangement of the heating surface and proportioning of the furnace to produce maximum radiant heat absorption and minimum slagging.

Constant steam temperature is maintained over considerable range of flow by a gas bypass around the superheater. Primary and secondary sections of the furnace are separated by a slag screen, open at the lower end to permit passage of the furnace gases and to allow the secondary furnace ash to flow back to the primary furnace. Waterwalls of the

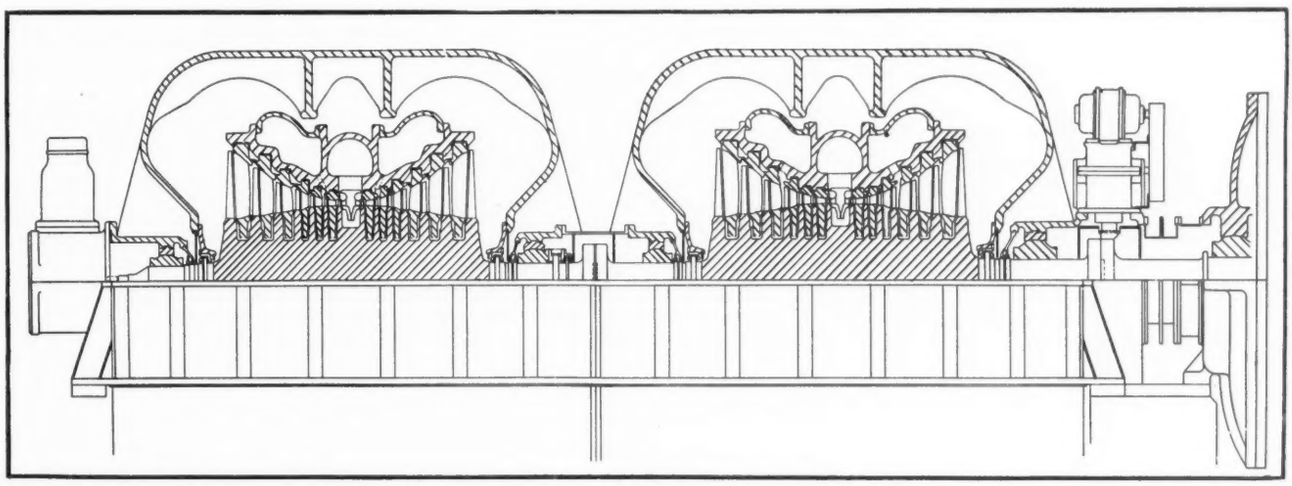


Fig. 6—Quadruple-flow, 3600-rpm, low-pressure element is supplied from cross-over piping below the turbine-room floor

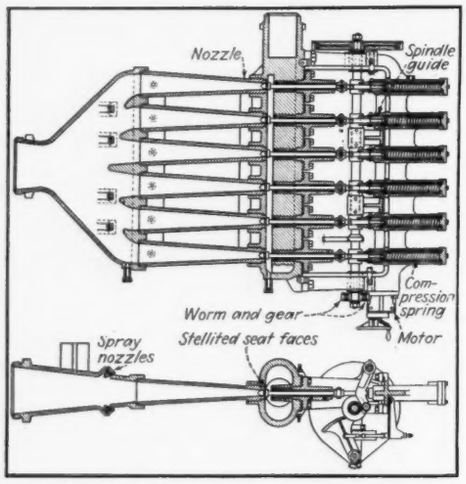


Fig. 7—Multi-port pressure-reducing valve with spray desuperheater supplies steam from 1250-lb boilers to either 650-lb or 200-lb steam systems

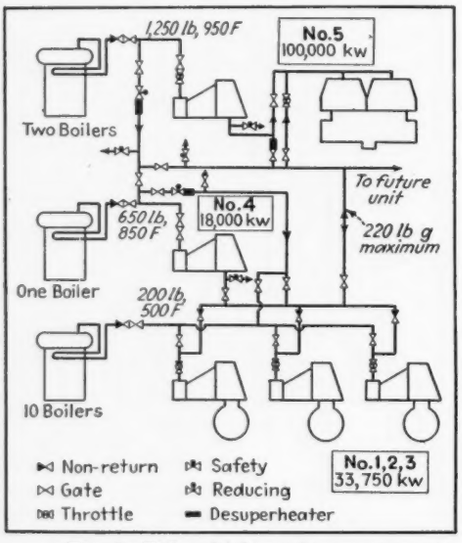


Fig. 8—Either high- or low-pressure element of new unit can operate separately by interconnecting with other turbines

primary furnace consist of partially studded tubes with plastic chrome ore between studs, while the secondary furnace is made up of bare tangent tubes. Furnace floor tubes are covered with cast-iron blocks protected by a layer of chrome ore.

The furnace is designed for continuous removal of slag through a single, elliptical, water-cooled opening near the center of the floor. This opening has a throat dimension of approximately 2 ft on its longer axis. Slag drips continuously through the opening, passing through a set of quenching sprays to a water-filled cylindrical steel tank. The tank provides for cooling and storage of slag between ash-removal operations. Storage capacity for approximately eight tons of disintegrated slag is provided in the tank of each boiler. Periodic slag removal from the storage tank is carried out by a motor-driven slag pump which conveys the disintegrated slag through a 6-in. cast-iron pipeline to an ash-disposal area approximately 1000 ft from the boiler house.

Downshot burners, in the arch of the primary furnace, are arranged to fire either pulverized coal or fuel oil. Pulverized coal is supplied to the six burners by two double-classifier Hardinge mills. Oil burners are standard mechanical-atomizing. Twelve atomizers per boiler are used in the same air registers and with the same control dampers as provided for coal firing. This permits changing from one fuel to the other with no alteration of the burners.

For starting up periods, when the furnace is cold and a slow firing rate is desired, four small-capacity air-atomizing oil burners are employed. Better ignition and burning conditions are obtained when firing small quantities of oil in a cold furnace with air atomizers than can be obtained with straight mechanical atomizers.

Electrostatic precipitators are between outlets of the air heaters and inlets of the induced-draft fans. With this location the induced-draft fans are required to handle only dust-free gases, with consequent reduced fan-blade wear. The precipitators have the recently developed perforated-plate electrodes, and the installation is designed for removal of approximately 95% of the suspended dust at maximum boiler load.

Dust separated from the flue gas is collected in 15 hoppers below the precipitator and connecting flue of each boiler. These hoppers, arranged in groups of three and four, discharge into a common hydro-pneumatic dust-conveying system. The discharge of this system is connected to the same ash-conveying pipeline that carries the furnace slag to the ash-disposal area. Operation of the dust-conveying system is pushbutton controlled remotely by the boiler operator at the boiler-control board. The pushbutton control operates successively the gang rotary feeders below each group of four hoppers, and also operates the sectionalizing Thrustor motor valves which segregate various parts of the system.

Gas flues and hot-air ducts are partly internally and partly externally insulated. Insulation was applied to the interior of the ducts particularly on those sections where frequent injury of the insulation might occur if installed on the exterior. Hot-air ducts from the air heaters to the burners and the burner casings were internally insulated. By placing all duct stiffener angles on the inside where internal insulation was employed, a clean-cut duct system was obtained. Block slag-wool insulation was used throughout on flat surfaces.

The electrical system begins with the 13-kv bus which ties the two generator elements together. From this bus, output of the generators is carried through cables to two 4000-amp outdoor oil circuit breakers and then to two 13-kv windings of a 117,000-kva (continuous rating with fans, 156,000 kva), 13/132-kv step-up transformer bank outdoors adjacent to the turbine room. This transformer bank consists of three 39,000-kva single-phase units. A spare unit is provided. Each of the 132-kv windings connects through a 3-conductor oilostatic cable to a 132-kv switch yard approximately 1200 ft from the station. There are three outgoing lines, two to Trenton Switching Station, one to Camden Switching Station.

Auxiliary power for the two new boilers and turbine is provided by four 4000-kva, 13,200/2300-volt, 3-phase auxiliary-power transformers, arranged in two banks with one bank connected to the generator bus and the other to one low-tension winding of the main transformer bank. Auxiliary power can thus be obtained from the transmission system for starting and can be maintained should a relay operation trip out either source of supply. The larger auxiliaries are fed at 2300 volts, 3 phase, 60 cycles, and the smaller auxiliaries (motors under 100 hp) are supplied at 230 volts, 3 phase, 60 cycles, through two 2300/230-volt, 1250-kva, 3-phase transformers fed from the 2300-volt system.

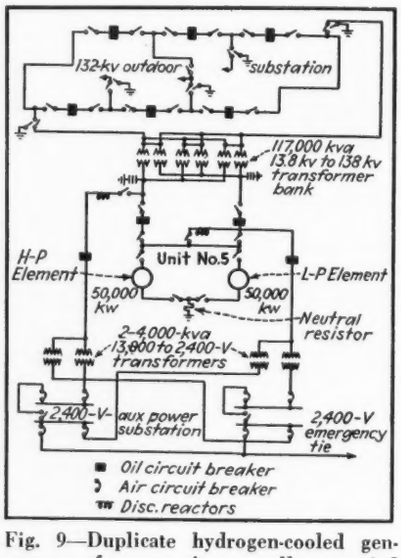


Fig. 9—Duplicate hydrogen-cooled generators of new unit normally are tied solidly together on the electrical end to supply 132-kv system

The coal-handling system, because of the expected ultimate size of the station and handling coal from large cargo steamers up to 10,000 tons, has a capacity of 500 net tons per hr (Fig. 12).

Coal received by boat or barge is unloaded at a fixed tower with a bucket having a capacity of 8000 pounds and delivered by belt to a Bradford breaker, 12 ft in diameter by 17 ft long, which crushes and screens the coal to a size not larger than 1¼ in.

A feeder belt receives the coal from the breaker and delivers it either to a conveyor to the station bunkers or to another conveyor to a storing boom. The boom is 90 ft long and can be swung through an angle of 110 deg to form an initial storage pile 35 ft high of approximately 7000 net tons.

Following unloading of a shipment, coal in the initial storage pile may either be reclaimed directly to the pit in front of the boom tower or carried to main storage. The feeder conveyor

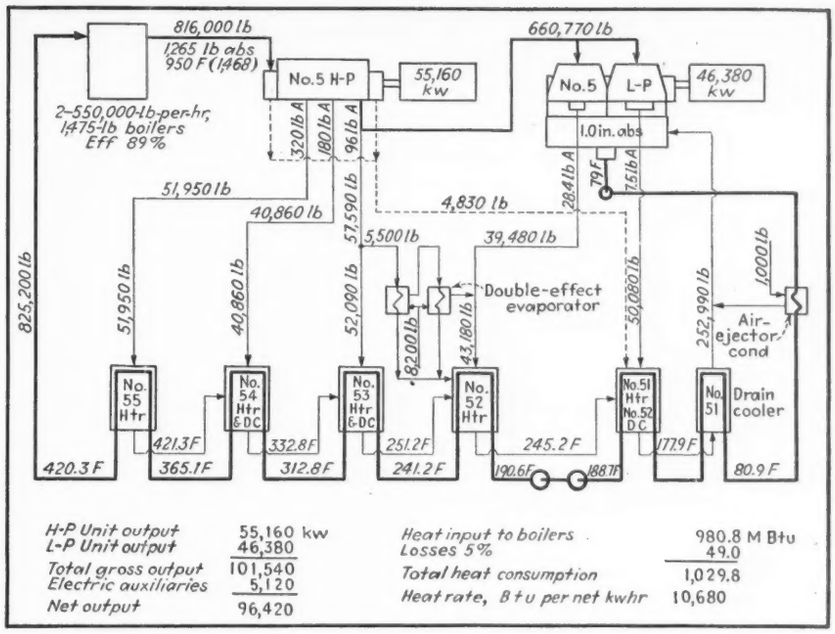


Fig. 10—Deaerating storage hotwell, five stages of feedwater heating in closed heaters with all drains cascading back to condenser comprise simple, efficient feedwater cycle

BOILERS AT BURLINGTON ARE ESSENTIALLY THE SAME GENERAL DESIGN AND PROPORTIONS AS THE ESSEX UNITS, WITH THESE MODIFICATIONS MADE AS THE RESULT OF OPERATING EXPERIENCE AT ESSEX

(1) Early trouble at Essex from carryover, unstable drum water levels and low circulation rates in the downcomers resulted in the development and installation of cyclone separators, which eliminated these difficulties. With the development of this improved separating device it was possible at Burlington to omit the small 36-in. upper front drum of the Essex type boiler and the riser tubes are carried directly to a single large drum, eliminating complications of an additional drum and connecting tubes.

Tests indicate that adequate provisions in this new design for dry steam, stable water levels and circulation have been made. Rates of circulation in the downcomers are approximately 75% greater than at Essex at equivalent loads. Measured rates of circulation of water in the downcomers are approximately fourteen times the steaming output of the boiler at the maximum capacity.

(2) Early operation at Essex with various coals and with fuel oil indicated a tendency for slagging in the first rows of the close-spaced superheater tubes. The number of rows of wide-spaced tubes at the entrance to the superheater was increased from three to eight on the Burlington boilers, with resulting improvement in ability to keep the superheater free from slag. Improved locations and types of soot blowers in the superheater and economizer as compared with the original Essex installation have also aided in maintaining cleaner tubes.

Steam supply for the Essex soot blowers was taken from the 200-lb system. On the Burlington units reducing valves provide saturated steam from the boiler drums at 600 lb pressure for the soot-blowing system. More effective cleaning is being obtained with the higher-pressure steam. Telescopic and retractable soot blowers in the superheater provide more effective cleaning in this section than was possible with the soot blowers originally installed at Essex. Soot blowers using the mass blowing principle were installed in the economizer instead of standard units. Improved cleaning in this section is also indicated.

(3) The gas bypass around the superheater on the Essex design boiler consisted entirely of economizer surface. The amount of gas which may be bypassed with this design is limited by steaming of the economizer. At Burlington part of this economizer surface in the bypass has been replaced by steam-generating convection surface. This has resulted in more flexible bypass operation. Installation of smaller horizontal dampers in the main uptake and bypass flues in place of the larger, vertical dampers at Essex has also provided better gas distribution in the economizer.

(4) Ash-pit and slag-removal facilities have been changed from the Essex design. Ash hoppers of the Essex boilers were at the bottom of the secondary furnace and extended full width of the furnace. These hoppers formed a waterfilled pit into which the molten slag from the primary-furnace floor dripped continuously, and into which dry ash and slag from the walls of the secondary furnace fell. This design exposes a large amount of refractory to the radiant heat of the primary and secondary furnaces and under the particularly bad conditions of alternate heating and chilling from water during ash removal periods, considerable spalling of the refractory occurs. The accompanying large amount of maintenance indicated that an improved design was desirable.

At Burlington the furnaces were therefore equipped with a single, small, elliptical, water-cooled opening near the center of the primary furnace floor, through which all of the ash from the primary and secondary furnace flows continuously after becoming fluid on the furnace floor. The cylindrical, steel, water-filled tank previously described is not exposed to the furnace heat as are the Essex hoppers, and thus the necessity for refractory lining is eliminated. Indications are that, with the improved design of ash pit, maintenance will be practically eliminated.

First cost of these hoppers is materially less than the Essex design. Absence of the wide ash pit extending across the entire furnace width has permitted the omission of one set of lower water-wall headers. In place of two lower furnace-wall headers a single mud drum, large enough for access, has been substituted. This has improved accessibility of the tubes and has eliminated a large number of hand-hole openings.

(5) The Essex boilers were designed on the basis of an expected 90% of air for combustion passing through the air heaters. Actual operating experience and tests indicated that setting leakage, particularly at the ash pit, resulted in less than 70% of air for combustion passing through the air heaters. This called for a tighter setting of improved design. On the Burlington units the changes in the setting, casing, and ash hopper have reduced air leakage and raised the figure to approximately 85%.

under the reclaiming hopper delivers by belt conveyor back to the Bradford breaker, thus serving to break up any frozen lumps of coal and to screen it again before passing to the station bunkers. A magnetic separator in the head pulley of the station conveyor removes small pieces of iron that may have passed through the breaker.

To handle coal received by railroad cars (not expected to be the usual method), advantage was taken of a portion of the existing coal-handling system. A second track hopper was provided and the series of conveyors speeded up to about 200 tons per hour to deliver coal to the new belt system. A house will cover both rail hoppers.

A new departure in the storing and reclaiming of coal is the use of two Caterpillar tractor units, each equipped with a "bulldozer" and a "carry-all" of 15 cubic yards (10 net tons) capacity. The bulldozer equipment is used for storing and reclaiming within a relatively close distance from the hopper, up to about 150 ft; the carry-all units are used for greater distances. This equipment makes the size and shape of the storage pile without limit and with the present fill approximately 300,000 tons of coal can be stored.

All of the new belts are 42 in. wide and are driven in most cases by chain belts from reducing gears directly connected to electric motors. The chain drives permit a more compact arrangement than possible with direct drive.

Preliminary operation of the unit has been particularly uneventful compared to usual starting experience with new equipment. One major failure occurred in the loss of the high-pressure-element generator field winding by failure of insulation on several end turns. This element was out of service about two weeks, the low-pressure element operating separately while the field was replaced by substitution of a duplicate from the new Marion installation, then not yet in service.

A theoretical heat balance based on equipment guarantees with 5% allowed for losses indicates a heat rate of 10,700 Btu per kwhr net station output (Fig. 10). Up to the present time the turbine has been operated with a temperature of approximately 925 F at the throttle. Acceptance tests have not yet been made. Daily station heat rates including the 650-lb superposed unit have been averaging approximately 12,000 Btu per kwhr net station output.

Design of the installation was carried out by the Electric Engineering Department, Public Service Electric and Gas Company, and construction by the United Engineers & Constructors, Inc.

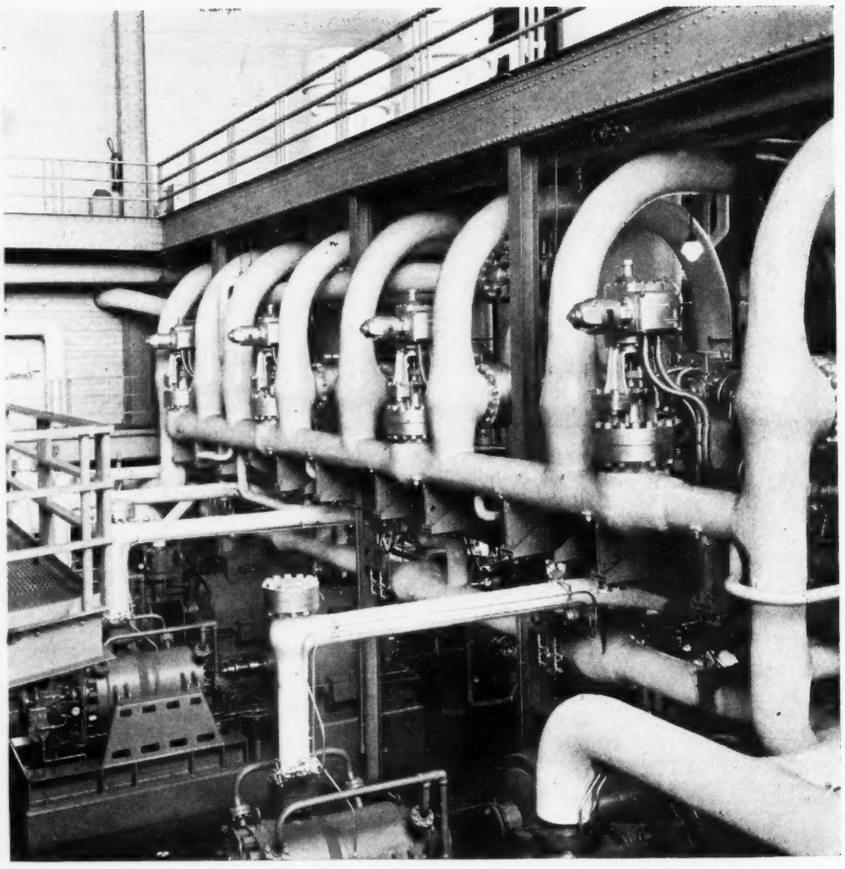


Fig. 11—Vertically mounted floating-head heaters are close together, connected by short runs of welded piping. Below are boiler-feed pumps

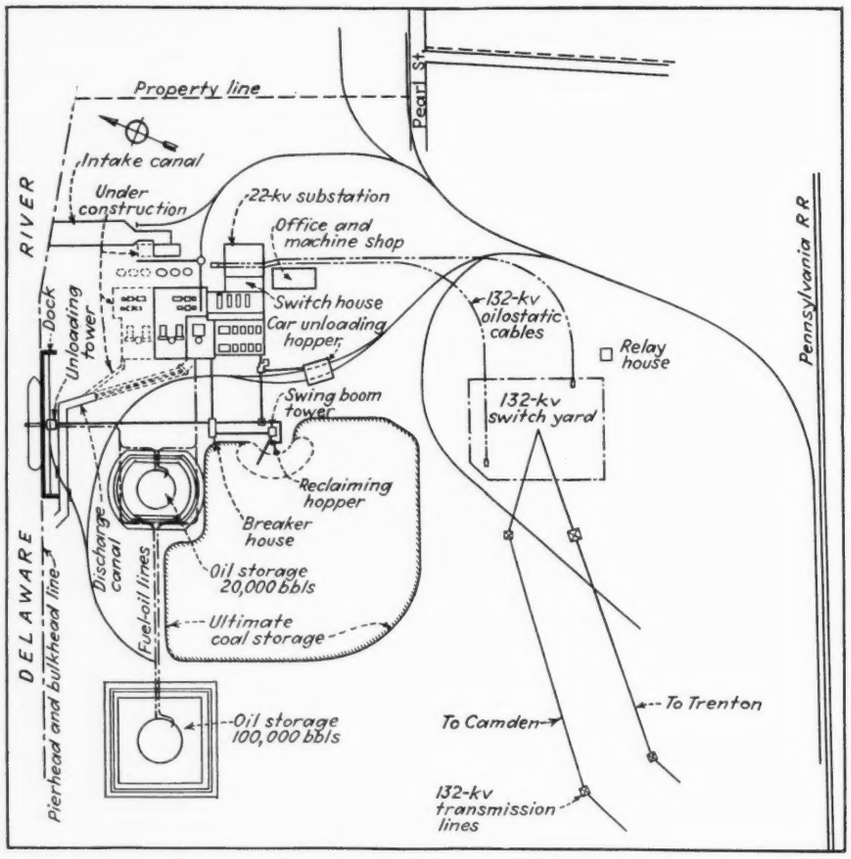


Fig. 12—Property plan shows coal-handling system for expected ultimate station. Storing and reclaiming are accomplished by bulldozer and carryall

Principal New Power-Plant Equipment—Unit No. 5

Burlington Generating Station, Public Service Electric and Gas Co, Burlington, N. J.

Steam-Generating Equipment:

Boilers and water walls.....Babcock & Wilcox Co
2 radiant boilers; heating surface, including water walls, 13,542 sq ft with slag screen; maximum continuous steaming capacity, 550,000 lb per hr; design pressure, 1475 lb g, total steam temperature 950 F; furnace volume 23,500 cu ft; heat liberation at maximum continuous steaming capacity, 27,300 Btu per cu ft per hr
Superheaters, 19,305 sq ft, counterflow.....Babcock & Wilcox Co
Economizers, 11,500 sq ft, counterflow.....Babcock & Wilcox Co
Air heaters, 2—49,700 sq ft, Ljungstrom, per blr..Air Preheater Corp
Ash hopper .....Allen-Sherman-Hoff Co
Boiler insulation .....Philip Carey Co

Boiler Auxiliary Equipment:

Coal pulverizers, 2—33,000 lb each per blr.....Foster Wheeler Corp
Hardinge type, double-classifier tricone ball mills
Pulverizer drive motor .....Allis-Chalmers Mfg Co
Constant speed, 300 hp, 360 rpm, 2300 volts
Coal feeders, 2 per blr, 29-in., table type.....Foster Wheeler Corp
Coal-feeder drive motor.....Westinghouse Elec & Mfg Co
Constant speed, 1 hp, 1200 rpm, 220 volts
Mill exhausters, 2 per blr, constant speed.....Foster Wheeler Corp
Mill exhauster driving motor.....Allis-Chalmers Mfg Co
Constant speed, 150 hp, 1200 rpm, 2300 volts
Forced-draft fans, vane control, one per blr.....B F Sturtevant Co
160,000 cfm at 120 F, 13 in. wg, 880 rpm
Forced-draft-fan drive motor.....Westinghouse Elec & Mfg Co
Constant speed, 900 rpm, 500 hp, 2300 volts
Induced-draft fans, vane control, one per boiler....B F Sturtevant Co
275,000 cfm at 350 F, 18 in. wg, 880 rpm
Induced-draft-fan drive motor.....Westinghouse Elec & Mfg Co
Two speed, 900 and 720 rpm, 1350 hp, 2300 volts
Ducts and breeching.....Connery Construction Co
Duct and breeching insulation (Eagle-Picher Co).....C S Wood Co
Coal burners, 6 per boiler, intertube.....Babcock & Wilcox Co
Oil burners, 12 per boiler.....Babcock & Wilcox Co
Soot blowers { one boiler .....Bayer Co
Soot blowers { one boiler .....Diamond Power Specialty Corp
Automatic combustion control.....Hagan Corp
Water columns .....Diamond Power Specialty Corp
Gage glasses .....Diamond Power Specialty Corp
1 Bi-color and 1 direct-sight type per boiler
Chemical feed pump.....Worthington Pump & Mach Co
Fuel-oil pressure control.....Hagan Corp

Coal-Handling Equipment:

Coal tower and conveying equipment.....Robins Conveying Belt Co
Coal crusher (Bradford hammermill type)..Pennsylvania Crusher Co
Coal scales, 2 weightometers.....Merrick Scale Mfg Co
Coal-handling-equipment drives.....Westinghouse Elec & Mfg Co
Speed reducers .....Falk Corp
Coal sampler (Geary-Jennings type).....Galigher Co
Magnetic pulley .....Cutler-Hammer Inc
Coal scales (2 per boiler) 18 tons per hr.....Richardson Scale Co
Tractors, 2, caterpillar type.....Caterpillar Tractor Co
Bulldozers, 2, for attachment to tractors.....R G Le Tourneau, Inc
Carryalls, 2, 10 tons capacity each.....R G Le Tourneau, Inc

Fuel-Oil Storage Equipment:

Fuel-oil storage tank.....Bethlehem Steel Co
1—100,000 bbl capacity, 120-ft dia, 40-ft high, all joints welded
Fuel-oil storage tank heaters.....Griscom-Russell Co
2—horizontal, G-fin, 250-gpm capacity each
Fuel-oil heaters, 2, vertical, 6-pass.....Alco Products Div
444 sq ft heating surface, hot-drawn seamless-steel tubes

Ash-Handling Equipment:

For furnace slag .....Allen-Sherman-Hoff Co
For dust from precipitator and breeching.....United Conveyor Corp
Precipitators, 1 Cottrell per blr (perforated plate type).Research Corp

Feedwater System:

Vertical feedwater heaters and drain coolers....Foster Wheeler Corp
1—High pressure, lockhead type heater, 3620 sq ft surface, 600 lb g design steam pressure, 2150 lb g design water pressure.
1—High pressure, lockhead type heater with integral drain cooler section, 3120 sq ft surface, 440 lb g design steam pressure.
1—High pressure, lockhead type heater with integral drain cooler section 3510 sq ft surface, 300 lb g design steam pressure.
1—High pressure, lockhead type heater, 3120 sq ft surface, 150 lb design steam pressure, 2150 lb g design water pressure.
1—Low pressure heater with integral drain cooler section, 5455 sq ft surface, 150 lb design steam pressure, 150 lb design water pressure.
1—Low pressure drain cooler, 2800 sq ft surface 150 lb design steam pressure, 150 lb design water pressure.
Tubes in high-pressure heaters and drain coolers, 80/20 cupro-nickel.
Tubes in low-pressure heaters and drain coolers, arsenical copper.
Heater-drainage controllers (5).....Bailey Meter Co
Boiler-water treatment.....Cyrus Wm Rice & Co
Evaporators .....Foster Wheeler Corp
2—400 sq ft surface, horizontal, submerged, self-scaling type evaporators, capable of being operated singly, or in series as a 2-effect evaporator. Rated capacity—15,000 lb per hr each, single effect; 23,000 lb per hr combined flow, double effect. Welded steel shell.
Evaporator drainage controllers (2).....Bailey Meter Co
Evaporator feed regulators (2).....Stets Co
Condensate pumps .....Worthington Pump & Mach Corp
2—2475 gpm each, 208 ft head, vertical shaft
Condensate pump motors.....Westinghouse Elec & Mfg Co
2—constant speed motors, 200 hp, 900 rpm, 2300 volts
Primary feed pumps.....Worthington Pump & Mach Corp
2—2750 gpm each, 1070 ft head
Primary feed pump hydraulic couplings.....American Blower Corp
2—1000 hp, 1800 rpm, Class IV, continuously running pump type
Primary feed pump motors.....Westinghouse Elec & Mfg Co
2—1000 hp, 1800 rpm, 2300 volts
Secondary feed pumps.....Worthington Pump & Mach Corp
4—832 gpm, 3060 ft head
Secondary feed-pump motors.....Westinghouse Elec & Mfg Co
3—1000 hp, 3600 rpm, 2300 volts
Secondary feed-pump turbine.....General Electric Co
1—1012 hp, 3600 rpm constant speed, non-bleeding
Secondary feed pump recirculation control..Republic Flow Meters Co
Feedwater-pressure control equipment.....Hagan Corp
Controls speed of hydraulic couplings
Feedwater level regulators, 3-element control.....Bailey Meter Co

Piping:

High-pressure fabricated piping .....M W Kellogg Co
Intermediate and low-pressure piping. { M W Kellogg Co / Midwest Piping & Supply Co / Simmons Pipe Bending Works
Circulating water piping.....U S Pipe & Foundry Co
Superheater-unloading valves.....Foster Engineering Co
1—2½-in. valve per boiler with auxiliary pneumatic hand control
650-lb steam-relief valves, 5—4x8 in.....Manning, Maxwell & Moore
200-lb steam-relief valves.....Manning, Maxwell & Moore
8—6 in. by 8 in.; 2—4 in. by 6 in.
200-lb steam-relief valves.....Atwood & Morrill Co
2—8 in. by 10 in., pilot operated; 2—5 in. by 6 in.
Soot-blower steam-relief valves, 2—2½x4 in..Foster Engineering Co
Blowdown valves 2—2½-in. tandem per boiler...Yarnall-Waring Co
Non-return valves, 12-in. angle type.....Edward Valve & Mfg Co
Steel gate, globe, and check valves.....Lunkenheimer Co
Bleeder check valves.....Atwood & Morrill Co
Spill valves for feedwater heaters.....Atwood & Morrill Co
Small high-pressure valves.....Edward Valve & Mfg Co
Small intermediate-pressure valves.....Henry Vogt Machine Co
Iron gate, globe, and check valves.....Wm Powell Co
Large iron gate valves, circulating water....Chapman Valve Mfg Co
Small bronze valves.....Lunkenheimer Co
Pressure reducing and desuperheating valve...Schutte & Koerting Co
1-12 in. by 20 in. multi-nozzle type, motor operated
Control for pressure-reducing and desuperheating valve: temperature .....Hagan Corp
pressure .....Bailey Meter Co
Auxiliary pressure-reducing and desuperheating valves, 2—4 in. by 8 in. angle type.....Schutte & Koerting Co
Control for auxiliary reducing and desup valves.....Hagan Corp
Turbine exhaust desuperheater.....Schutte & Koerting Co
Soot-blower pressure-reducing valves, 2.....Swartwout Co
Auxiliary exhaust-steam relief valves.....Cochrane Corp
Pipe hangers, constant-load, Genspring.....Grinnell Co
Traps .....Armstrong Machine Works
Heat insulation, piping and auxiliaries (J-M material).H W Porter Co
Welding electrodes .....Metal & Thermit Corp
Inspection .....Hartford Steam Boiler Inspection & Ins Co

Meters and Instruments:

Boiler meters, recorders and draft gages.....Bailey Meter Co
Temperature recorders .....Leeds & Northrup Co
Fuel-oil and water meters.....Neptune Meter Co
Indicating flowmeters .....Republic Flow Meters Co
Recording flowmeters .....Bailey Meter Co
Condensate-conductivity recorder, 6-point.....Leeds & Northrup Co
Speed and cam-shaft-position recording equipment..General Elec Co
Hydrogen and CO_2 gas analyzers.....General Electric Co
Industrial indicating thermometers..... { Taylor Instrument Cos / Foxboro Co
Pressure gages .....Consolidated Ashcroft Hancock Div
Electrometric pH meter.....Scientific Glass Apparatus Co
Combustible gas indicator.....Mine Safety Appliances Co
Test gages .....Jas P Marsh Corp
Vacuum columns and barometer.....Taylor Instrument Cos
Portable fluid pressure scale.....Crosby Steam Gage & Valve Co
CO_2 recording equipment.....Leeds & Northrup Co
Portable CO_2 gas analyzers.....Ellison Draft Gage Co

Service Equipment:

Turbine-room crane .....Whiting Corp
Boiler-room elevator .....Otis Elevator Co
Mulsifyre systems.....Grinnell Co
Extinguishers..... { American-La France Foamite Corp / C-O-Two Fire Equipment Co / Pyrene Mfg Co
Air compressor for combustion control.....Ingersoll-Rand Co
Service and fire pumps..... { Ingersoll-Rand Co / De Laval Steam Turbine Co
Oil-purification equipment .....De Laval Separator Co
Open drip tank.....Cochrane Corp
Open-drip-tank pump, vertical.....Worthington Pump & Mach Corp
Open-drip-tank pump, vertical.....Worthington Pump & Mach Corp
Flood pump .....De Laval Steam Turbine Co

Turbine-Generator and Auxiliaries:

One 100,000 kw, 80% pf, 3600 rpm.....General Electric Co
Cross-compound turbine, consisting of a high-pressure element and a low-pressure element. Turbine has five points of steam extraction. Normal steam conditions at throttle 1250 lb, 950 F. Two 50,000-kw, 80% pf, 62,500-kva generator elements directly connected to the turbine elements, hydrogen cooled, 3 phase, 60 cycle, 13,800 volts. Two 200 kw, 250 volt gear-driven exciters, 1775 rpm.

Surface Condenser and Auxiliaries:

One, 55,000 sq ft, single-pass.....Westinghouse Elec & Mfg Co
Welded shell construction with divided cast-iron water boxes. Two 43,000-gpm each, vertical propeller circulating pumps. Two 350-hp, 600-rpm, 2300-volt vertical-shaft motors with thrust bearing. Two 2-stage steam-jet air pumps, using 200-lb, 550-F steam.
Condenser tubes.....Phelps Dodge Copper Products Co
55,000 sq ft, ⅞ in. od, No. 18 BWG, Admiralty metal, 30 ft long.
Intake water screens.....Link-Belt Co
Two 6 ft wide (one 8 ft wide for existing condensers) vertical revolving type screens each with 5-hp, 1750-rpm driving motor, speed reducer, refuse trough and spray piping.
Sluice gates .....Krajewski-Pesant Mfg Corp
Two 7 ft by 10 ft, Limitorque operated, direct-pressure type for new condenser. One 9 ft by 10 ft, Limitorque operated, back-pressure type for existing condenser.
Chlorination and desliming equipment...Wallace & Tiernan Products
Condenser-hotwell level control.....Bailey Meter Co

Motor Operation Simplifies Valve Control

C W Kuhn, supervising engineer, Development Department, Cutler-Hammer, Inc, tells where to use motor-operated valves, how they operate and explains in detail the electrical control circuits

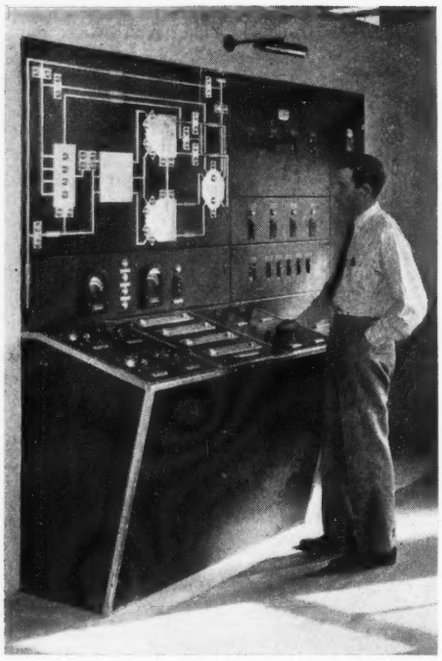


Fig. 1—Main panel from which several motor-operated valves are controlled

▶ MOTOR-OPERATED VALVES have been developed for a wide range of applications in power plants, oil refineries, water works, sewage plants, ships, paper mills, and on compressed-air lines. These operators, with their control equipment, offer many advantages over manual operation of medium and large-size valves for they permit local control of valves as well as control from one or more remote points.

Valves in inaccessible places can be remotely controlled so that, in case of a line break, the valve can be readily closed and the hazard to life and property kept to a minimum. Control of important valves in a plant may be placed in a single location under the direction of a responsible operator. All the valves of a complicated process may be operated according to a pre-arranged schedule, to meet the process requirements, thus eliminating the human element in their operation.

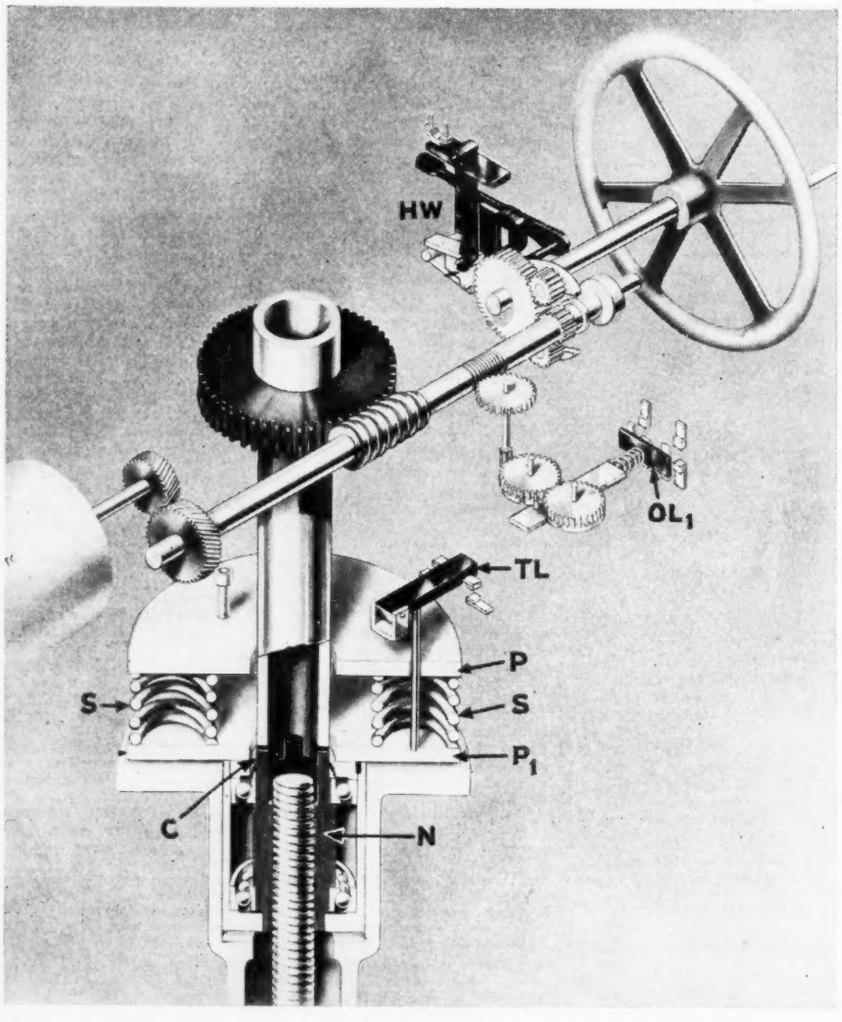


Fig. 2—Operating mechanism of an electric valve operator that will automatically seat the valve against a predetermined thrust

Recent power-plant installations have continued the trend toward ever-increasing temperatures and pressures. These changes add to the importance of motor operation of valves. Refinery processes, developed in the past few years, are controlled by motor-operated valves through a pre-arranged program timer. For proper results these valves must be completely interlocked to avoid failures and subsequent hazards, and must close "leak-tight." The logical answer is motor-operated valves.

Rate of Valve Closure

Municipal water-filtration and sewage-disposal plants present a large and growing field for motor operation which permits remote control plus convenient and easy operation of large valves and gates.

Motor-operated valves make possible closing and opening valves at almost any desired rate. For example, a 14-in. valve may be opened or closed at a speed as high as 100 in. per min., or as slow as 7 in. per min. That is, the

valve may be opened or closed in less than 9 sec or in over 2 min.

A motor-operated-valve unit consists of a motor with suitable gearing for driving the valve-yoke nut. Limit switches stop the valve at either extreme of travel. Suitable electrical control operates the motor in either direction. Figs. 3 and 4 show wiring diagrams of two such controls.

Fig. 3 is for a 3-phase, squirrel-cage-motor-driven valve operator. This motor connects to the line through 3-pole reversing contactors *O* and *C*. When contactor *O* closes it connects lines T_1, T_2 and T_3 directly to T_1, T_2 and T_3 motor terminals. Closing *C* contacts connects T_1 line with T_2 terminal on the motor and T_1 on the motor with T_2 line for reverse operation. T_3 line connects to T_3 motor terminal as before. *C* and *O* contacts are so interlocked mechanically that when one group is closed the other must be open.

Thermal overload relay *OL* in series with motor leads T_1 and T_2 opens contact *OL* in series with the control circuits to protect the motor against abnormal conditions. In most applications the operator will open or close the valve in a few seconds. The overload will not trip under such normal operation no matter how heavy the load on the motor. If for some reason, such as low voltage, the motor should stall, overload relay *OL* will open to prevent burning out the motor windings.

Pushbutton Operated

Pressing the open or the close pushbutton causes contactor *O* or *C* to close and operate the valve in the proper direction. At any time when the unit is operating, pressing the stop button deenergizes the contactor coils to stop the motor. Position limit switches CL_2 and OL_2 in circuit with indicating lights *R* and *G* show when the valve is in open, closed, or intermediate positions. When in the intermediate position both limit switches are closed and both lights burn. When the valve is completely open, OL_2 opens and only the red light burns. Similarly, when the valve is completely closed CL_2 opens and only the green light burns. Limit switch OL_1 in series with the open pushbutton opens to stop the valve when it nears open position. Thrust switch *TL* permits the valve to be closed against a predetermined thrust or seating pressure.

Fig. 2 diagrams the valve operator and how the valve is thrust-seated. Valve-yoke nut *N* is motor-driven by a worm and gear through jaw clutch *C*. Heavy spiral springs *S* are compressed and held between bottom plate P_1 and

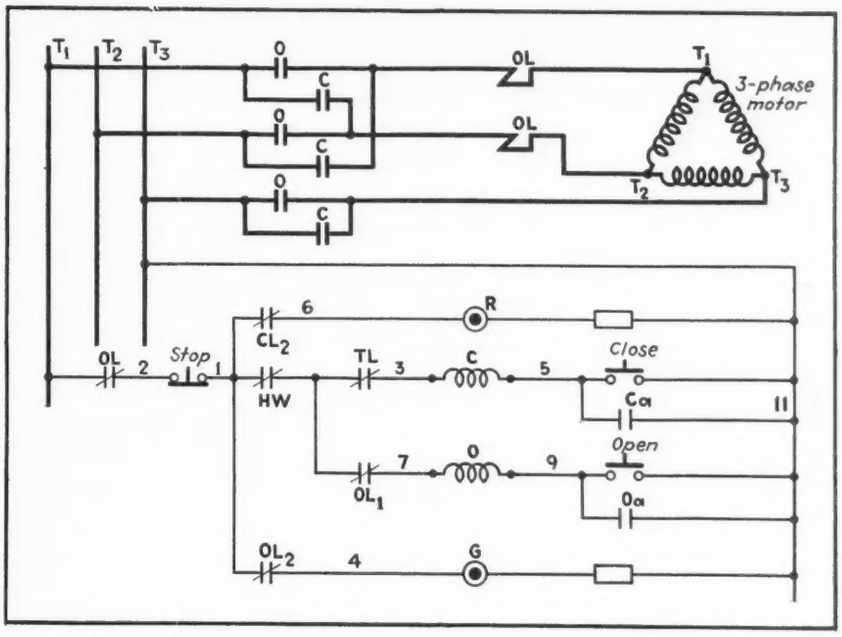


Fig. 3—Control circuits for an alternating-current-motor-operated valve

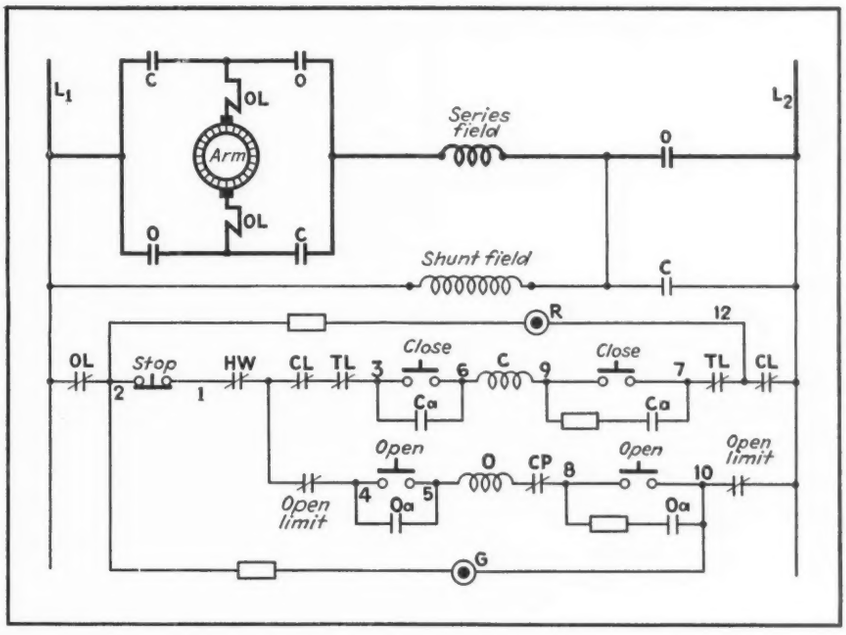


Fig. 4—Control circuits for a direct-current-motor operated valve

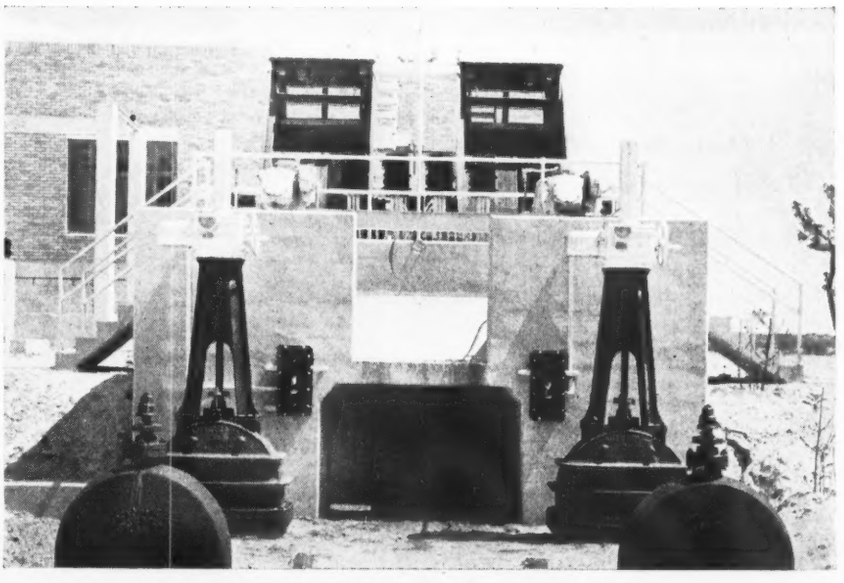


Fig. 5—Two motor-operated valves control inflow to Dallas sewage-treatment plant

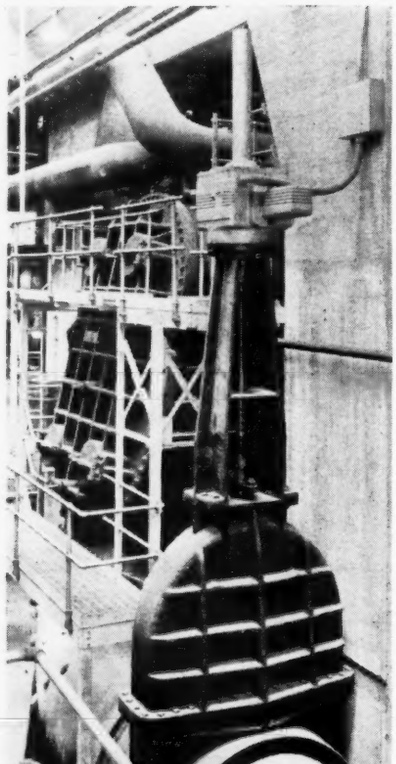


Fig. 6—Motor-operated valve in 60-in. condenser-circulating-water intake in a modern central station

top plate P; the latter is held stationary while the bottom one rests on valve-yoke nut N.

During seating of the valve, when loading on stem exceeds compression of the springs, plate P_1 starts to move upward. When predetermined thrust-seating load has been reached, thrust-limit switch TL opens, as in the figure, and stops the operator. Kinetic energy of the moving parts, nearly all of which is in the motor, is then absorbed by a further climbing of the yoke nut and plate P_1 against the thrust springs. The amount of kinetic energy which these springs must absorb in this way is a minimum because a considerable part is lost in the valve unit gearing and the yoke-nut threads.

Thrust-Seating Springs

Thrust-seating springs not only insure seating the valve with a safe predetermined thrust, but the springs absorb effects of temperature change on high-temperature valves. Changes in length of valve parts, due to changes in temperature, are immediately taken care of by the thrust springs. Consequently, there is no danger of jamming the valve against its seat or buckling the valve stem. The springs also protect the valve from over-stressing in case foreign material lodges in the valve seat.

It is common practice to provide for manual operation of valves equipped with motor-driven operators. This is frequently incorporated as a part of the power unit, as in Fig. 2. Turning the handwheel engages a drive to open or close the valve as desired. When the valve is being operated by the handwheel an electrical interlock contact HW opens to prevent motor operation.

Control Circuits

To trace the operator control circuits, Fig. 3, assume that the valve is closed. Then position-limit switch CL_2 and thrust-switch TL are open, which put out red lamp R and opens the circuit through the close button. Open limit switch OL_1 is closed as is also position limit switch OL_2 so that the green lamp is lighted, and if the open button is pressed a closed circuit is completed through open contactor coil O, contacts OL_1, HW and OL and the stop button to line T_1. Energizing opening coil O closes contacts O in the motor circuit and the operator starts opening the valve.

Auxiliary contact O_a also closes to complete the circuit around the open button so that it can be released and the operator continues to run until stopped by open limit switch OL_1.

Pressing the close button energizes coil C. Contacts C in the motor circuit then close and start the operator closing the valve. Once started, the operator continues to close the valve until stopped by thrust limit switch TL, as previously explained. The valve may be stopped in an intermediate position by pushing the stop pushbutton. After the valve has been stopped in this way the operator will not start again until either the close or the open button has been pressed.

Fig. 4 shows a similar wiring diagram to Fig. 3 for a direct-current motor. This diagram, however, provides for double-line break control contacts to prevent the remote possibility of faulty operation due to grounded circuits. Double-pole push buttons, thrust-switch, and limit-switches are also included to open both sides of the coil circuit. The control system, Fig. 4, has a closing-preference auxiliary contact CP in the coil circuit for contactor O. The closing contactor coil can be energized at any time even though the valve is being operated in open direction. When the closing button is pressed, closing contactor C will move against the mechanical interlock. This motion is sufficient to open contact CP to de-energize open contactor O. When O drops out, closing contactor C can close to reverse the motor and close the valve.

Additional circuits can be added to control valves from more than one point. In many power plants all motor-operated valves are controlled from a central control panel with local control stations adjacent to the valves. Fig. 1 shows one such central control panel arranged for convenient operation.

Control Arrangements

Control arrangements for valve operation can be varied to meet almost any requirement. The valves can be interlocked for proper sequence of operation. Operation can be started and stopped automatically by changes in water level, pressure, temperature, etc. All of the controls for a complete system can be grouped in one location. This can be supplemented with individual controls at or near the valves and either the local or remote station can be arranged to provide preference over the other control station. In fact, it is no longer how can you control a valve, but how do you want it controlled.

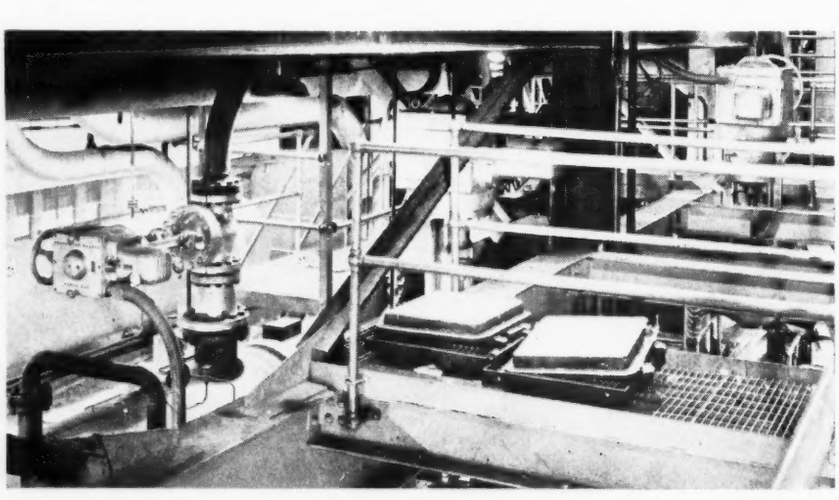


Fig. 7—Three motor-operated valves on central-station high-pressure boilers

Furnaces for Wood Burning

L E Webber, University of New Hampshire, follows his article on combustion fundamentals for wood (March) with practical data on furnaces and firing equipment for dry or wet waste

► WHETHER WOOD WASTE is dry or wet determines to a large extent the general nature of the equipment and furnace design needed for successful combustion. Installation details are also affected by several other considerations.

For example, burning wood alone presents a somewhat different problem than burning wood in combination with coal, oil, or gas. Where there is more than enough waste fuel, efficiency has little economic value and disposal may be a major problem; where wood waste meets only a part of fuel needs, efficiency is worth paying for. Small installations differ from large ones and temporary plants, such as those in logging areas, differ from permanent setups.

Burning Dry Waste

There are two methods of burning any fuel—in suspension or on a grate. In the case of wood, suspension burning is only practical when the amount of moisture present is low. Where kiln-dried waste is available, as in furniture factories and other plants producing finished wood products, suspension burning offers many advantages. High efficiency may be obtained in a more or less standard furnace, having about the same volume as for pulverized-coal firing. Combination burning is easily arranged.

For suspension burning, uniformity and small particle size are important. In most cases, the wood particles are blown into the upper part of the furnace. Secondary air, introduced near the bottom of the furnace, helps to keep the particles in suspension until burned; particles that drop to furnace floor burn there with secondary air.

Fig. 1 shows an installation of this type. Secondary air is delivered to the bottom of the setting, impinging on the floor at high velocity. According to C S Gladden, who describes this installation in "Boiler Settings for Burning Refuse Wood" (Transactions ASME, FSP-53-3-23), wood did not accumulate on the floor during operation. A comprehensive discussion of operating a suspension-burning installation appears in POWER, January, 1941, page 97.

A grate-fired design suitable for a small plant is shown in Fig. 2, from "Wood-Burning Furnaces" by Burritt A Parks (Transactions ASME, WDI-50-16B-32). Waste from the separator flows via chute and spout to the front wall of a small extension furnace and thence to a flat grate. Some fine particles burn in suspension but practically all burning takes place in the pile formed on the grate.

There are two major difficulties with an installation of this kind: (1) there is no control over the amount of air entering with the fuel, usually excessive, and (2) rate of fuel feeding is apt to be irregular, causing variations in combustion conditions in the furnace. While far from ideal, this general scheme has the virtues of simplicity and low cost and is often used where expense of a more elaborate arrangement is not justified.

Where coal is burned, either separately or in combination with wood waste, an arrangement somewhat similar to that shown in Fig. 2 can be used; a stoker takes the place of the flat grate. In a typical installation, POWER, June, 1941, page 68, the feed spout enters the upper front wall of a standard furnace and the wood falls on a single-retort underfeed stoker. Furnace volume was increased about 25% to allow for burning wood. Operators set feed rate for the waste at a point below average steam requirements; automatic combustion control varies coal feed to keep steam pressure constant. Both overfeed and chain-grate stokers have also been used for burning wood.

From a practical standpoint, wet wood waste can only be burned successfully on a grate set in an extension furnace or Dutch oven. To burn wet wood, the moisture must be driven off first. This requires heat. So does the second stage of the process, distillation of volatiles. Such heat can be best supplied by radiation from nearby hot surfaces. It is difficult to provide such radiant surfaces in a furnace large enough for satisfactory combustion of the released volatile matter. This conflict in requirements is solved by dividing the job into two parts and using what is often called a "2-stage" furnace.

The extension furnace or Dutch oven, the first stage, has a low roof arch and is usually all refractory-lined to secure maximum heat reflection to the incom-

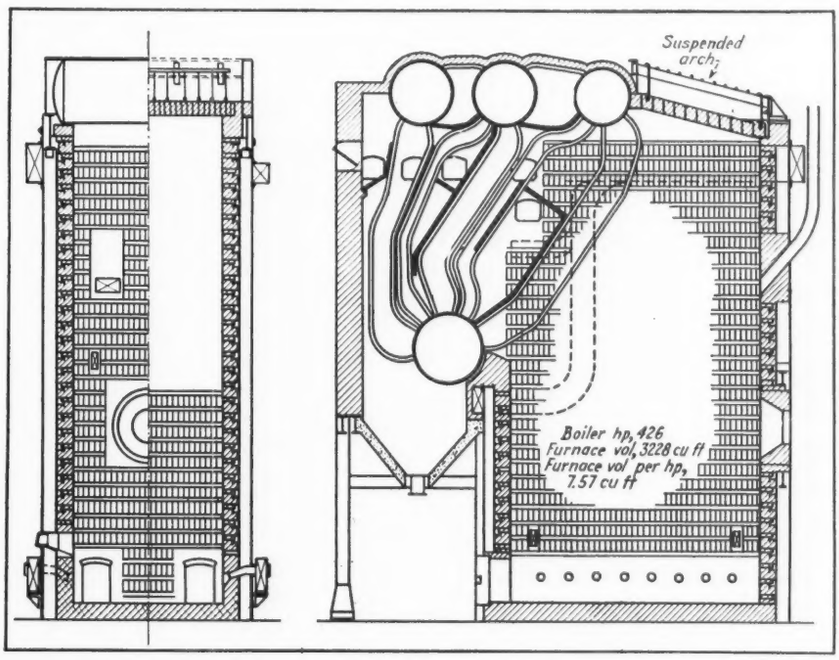


Fig. 1—Furnace for suspension burning of dry hogged fuel with pulverized coal

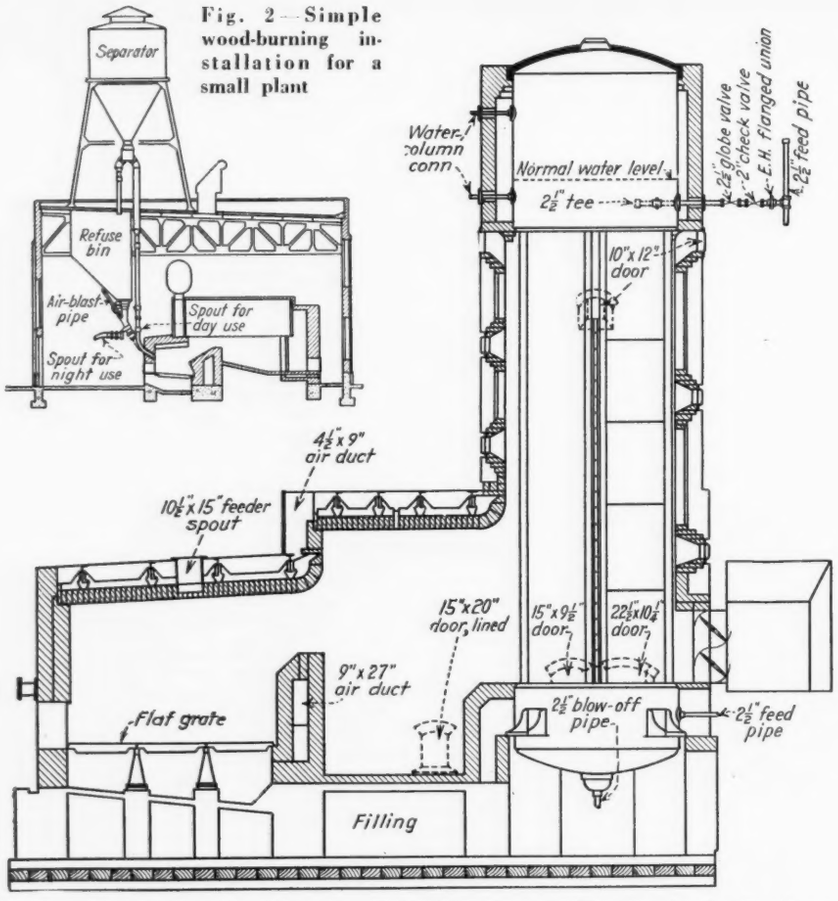


Fig. 3—Flat grate in Dutch oven used for burning sawmill waste in the Northwest

ing fuel. This reflected heat dries the fuel and distills the volatile matter, which starts burning at the fuel-bed surface. Heat from the burning volatiles, and from the small amount of fixed carbon burned on the grates, keeps the brickwork at red heat and thus maintains the drying and distilling action.

Since most woods run about 80% volatile matter (on a dry basis) complete combustion of these gases is important. This starts in the Dutch oven but most of it takes place in the main furnace where volume is ample to assure complete combustion before the gases strike the relatively cold boiler tubes. The effectiveness of mixing between air and volatile matter depends to a large extent on the shape of the two furnaces and the method of introducing secondary air. Furnace shapes vary considerably but most include a bridgewall between primary and secondary furnace; some employ a drop-nose arch to form a sort of throat between furnaces.

Amount of primary and secondary air and the distribution of secondary air are disputed points. In theory, nearly all air should be admitted over the fire where most of the burning takes place, but practical considerations usually dictate passing a substantial part through the grate to keep metal temperature down and to aid the drying process.

More important than amount of secondary air is the method of introduction. High velocity is important to insure good mixing of air and volatile matter. Location of tuyere or inlet ports and direction of air blast must be adjusted to furnace contours, to promote turbulence and mixing. Time spent in experimenting with an individual unit to determine the way to get best results from secondary air admission is usually profitably spent. Frequently, excessive smoking can be traced to stratification of the gases, a condition that can be remedied by secondary air admission.

Where flat grates are used, fuel is usually burned in conical piles. Placing feed chutes about 7 to 10 ft above the grates and 7 ft apart usually permits the fuel to pile up to a height of about 3 ft above the grate. Fig. 3 shows a 2-stage furnace with flat grate, applied to a vertical water-tube boiler (C S Gladden, Transactions ASME, FSP-53-3-23). Such units find wide use in the logging areas of the Northwest for temporary installations.

Fig. 4 shows a much more elaborate installation at L Street Station, Portland, Ore. The Stirling boiler is fitted with four Dutch ovens on each side. The slightly sloping grates are formed of flattened seamless-steel tubes welded into pressed-steel headers; this forms a water-cooled grate. The conveyor carrying hogged fuel passes over the Dutch-oven cells, each fed by a chute with a handwheel-operated gate to control feed from conveyor to chute. Fuel accumulates in the upper part of the chute until its weight forces open a flap and dumps the load on top of the conical fuel bed. The flap then swings back to keep cold air out.

Use of preheated air helps dry the fuel. The forced-draft fan only works against the preheater resistance; a small negative pressure is carried in the furnace to avoid blowing light fuel over into the main furnace. When oil is to be fired, the boiler is allowed to cool and the arch openings between Dutch ovens and main furnace are bricked over (see POWER, November 1939, page 74).

Inclined grates, set at an angle of 30-50 deg with the horizontal, work well with wet wood. The fuel is spread evenly over the entire grate surface; thickness of the bed varies from a maximum at the front to a minimum at the rear. The front thickness should be about 18 in. for coarse hogged wood and about 15 in. for sawdust.

Special Inclined Grate

A special form of inclined grate, developed for efficient burning of wet-waste fuels and widely used for burning bark in paper mills, is shown in Fig. 5. This "stoker" has three sections, one for each of the three major combustion stages. Wet bark or wood waste falls from a feed chute onto a refractory hearth, sloping at 50 deg, where it dries and slides to a herring-bone-grate section, sloping at 45 deg. On this second section, distillation occurs. The suspended-arch roof is shaped to concentrate radiant heat on the first two grate sections and the refractory hearth provides additional heat-holding capacity where it will do the most good. Final combustion, consisting mainly of burning fixed carbon, takes place on the last grate section inclined at a lesser angle and equipped with fuel pushers.

Controlled flow of fuel through a tight feed system prevents introduction of cold air at a point where refractory temperature must be kept as high as possible. The forward-tilted bridgewall works with the arch contour to force lighter, hotter gases from the lower end to mix with heavier gases from the top. Overfire air, supplied through tuyere

castings in the bridgewall, promotes turbulence and through mixing. Without water-cooling, grates of this type can handle up to 1500 lb of bark per ft of furnace width, per hr, which means from 3500 to 5000 lb of steam per ft of width, per hr. Higher rates can be carried on water-cooled grates, without excessive grate maintenance.

Wood-waste-burning units, operated at high rates, particularly with forced draft, present a problem in the form of carryover of unburned particles to the secondary furnace. Various methods have been used to burn this carryover material. Hollow refractory tunnels, extending the length of the boiler furnace and parallel to the wood-burning furnace, have been installed, with slots for admission of forced-draft secondary air. The carryover drifts against the tunnels and burns there. In later designs, these refractory tunnels have been replaced by rows of pinhole grates set in a tube-and-tile floor.

No Refractory Troubles

It has been found that burning wet wood rarely, if ever, produces refractory troubles; presence of moisture evaporated from the wood tends to keep furnace temperature down to around 2000 F or less. The small amount of ash formed has silica and alkaline constitutents producing a low-fusion-temperature slag which fluxes readily with ordinary firebrick. Use of brick with a high alumina percentage has been of some value in reducing refractory maintenance in dry-wood-burning units, but it is usually necessary to resort to air or water-cooling of walls to keep refractories below the temperature at which silica of the firebrick will fuse with ash and cause erosion.

It is frequently difficult to keep the furnace at a temperature which will not fuse refractories and yet high enough to reduce smoking. Experience with a particular unit is necessary to determine the best method to be used in bringing about this combination of conditions. When burning wood high in resins, more difficulty is usually encountered in obtaining smokeless combustion. It is usually wiser to permit some smoking than to raise the furnace temperature excessively.

When dry wood is used as fuel there are a few points which should be watched to prevent explosions and fire. Use of a rotary feeder in gravity feed chutes will prevent flarebacks through the chutes to the bin. Fuel should not be allowed to collect in a hot furnace not being fired without provision for igniting the gases distilled from the wood. Large volumes of distilled gases, mixed with the proper proportion of air, can explode with great violence. No great problem is involved in seeing that this gas is burned as fast as it is made; burning a few papers in the furnace will serve the purpose. One other source of explosion and fire lies in permitting a bed of coke to form over wood which has not had volatile matter distilled from it.

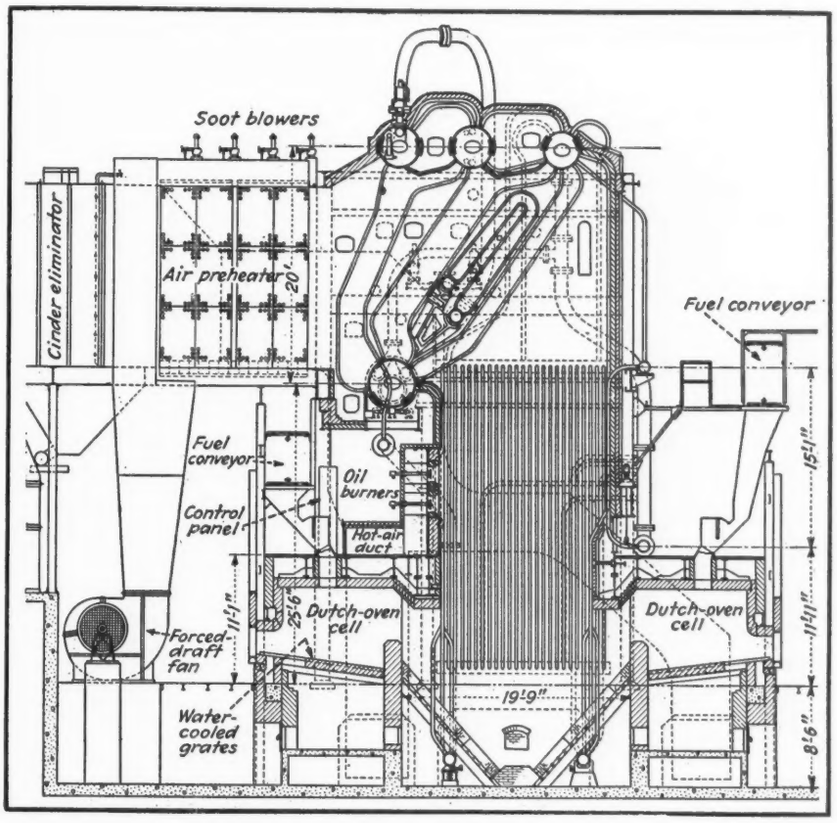


Fig. 4—Large central-station boiler fitted with 4 Dutch ovens on each side for burning hogged fuel; oil firing is supplementary

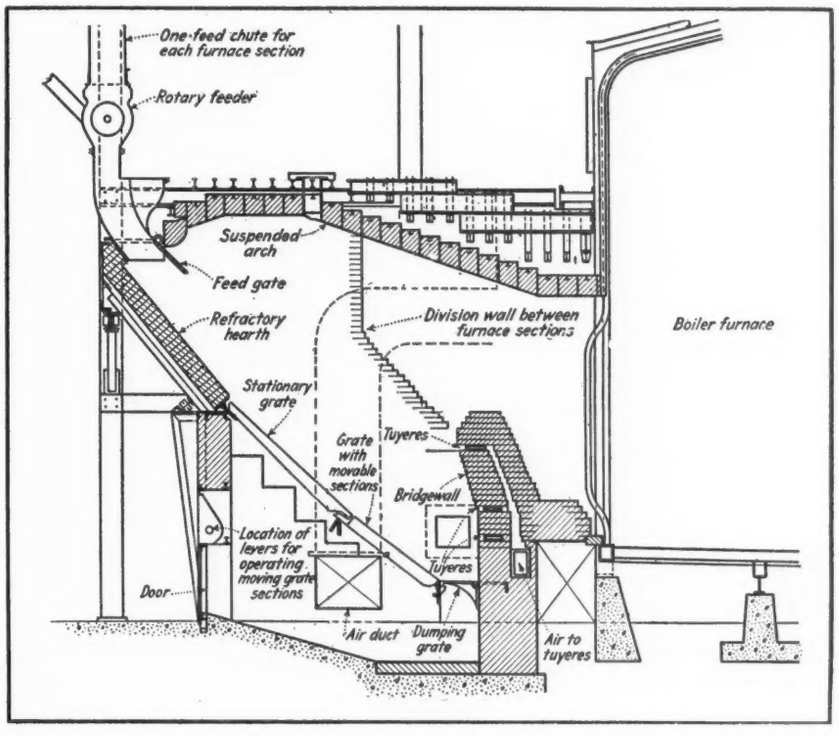


Fig. 5—Special inclined grate for wet waste fuels, typical of numerous recent installations burning pine bark in paper-mill plants

L H Gilmer Co plant at Tacony, Philadelphia, Pa.

Low-Cost Treatment Rescues Process Cooling-

When iron deposits put L H Gilmer Co's rubber-processing cooling-water system out of commission, a $6000 aeration and filtering plant saved the day. Operating and maintenance costs amount to only a few cents a week

By R Y CASE and S F ALLING
Superintendent, L H Gilmer Co and Vice-President, Hungerford & Terry, Inc

▶ SEVERAL YEARS AGO L H Gilmer Co, Tacony, Philadelphia, Pa., transmission-belt manufacturers, installed a 260-ft deep, 8-in. artesian well with a 250-gpm deepwell pump to supply cooling water for its rubber-processing equipment. After the system had been in service several months, heavy iron deposits clogged up piping so much that the plant had to return to expensive higher-temperature city water.

The company, having spent about $5,000 on the well system, called in several water-filtration-plant manufacturers to see if there wasn't some economical and effective treatment to get around the problem. In the short time the well system was in operation, iron deposits had reduced the cross-section of a 2-in. pipe by over 50%.

An analysis of the well water, as pumped, showed the following:

	Ppm
Free carbon dioxide as CO_2	72.0
Total iron (all in solution) as Fe	23.5
Manganese (all in solution) as Mn	0.35
pH	6.2
Chlorides as Cl	18.0
Sulphate as SO_4	53.5
Alkalinity as $CaCO_3$	34.0
Total hardness as $CaCO_3$	82.0

Note: Water *clear* when pumped.

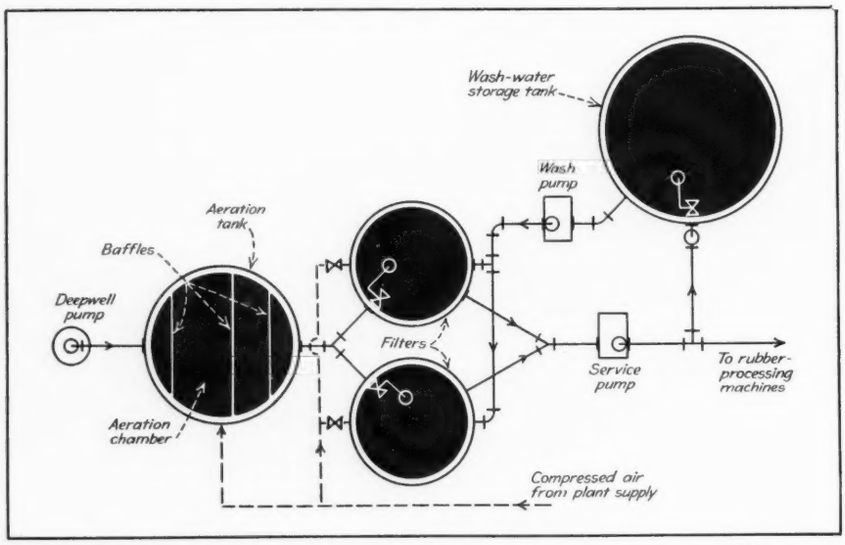
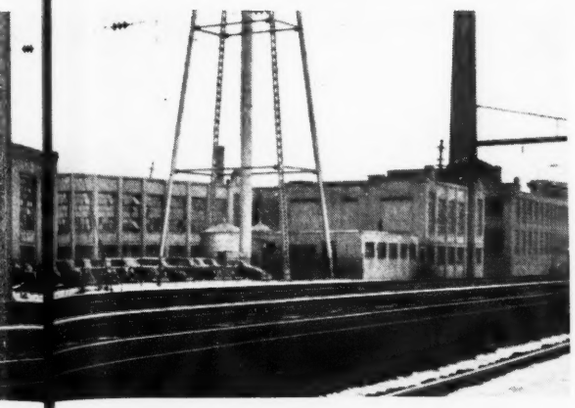


Fig. 1—Efficient backwashing gets much of the credit for the success of this setup

Plant requirements called for a water as low in temperature as possible and one containing a minimum amount of iron and other impurities. Several methods of treatment were considered —the one selected, a combined aeration and filtration plant — is shown schematically in Fig. 1. The three steps in this particular method are: (1) thorough aeration *without any chemical treatment*, (2) filtration, and (3) filter backwashing with air and water.

Aeration alone is depended upon for release of CO_2 and precipitation of the large amount of soluble iron. Porous air-diffusion tubes mounted in bronze supports, from which the tubes can be readily removed for cleaning, receive a definite amount of air supplied under pressure from an available supply of surplus compressed air.



Water System

Despite the low temperature, 57 F, in the well water and the high degree of solubility of CO_2 in water at this temperature, aeration and discharge of CO_2 are very effective. While water entering the aeration tank is sparkling crystal clear, aerated water leaving the tank a few minutes later already shows visible evidence that much of the dissolved iron has been precipitated. By the time the water enters the filters, the soluble iron has been nearly 100% precipitated.

The aeration tank is built of 3-in., close-grained Virginia white cedar, dressed to $2\frac{3}{4}$ in., and the temperature increase in the water passing through this tank is so small it can't be measured by conventional means. Three aeration baffles in the tank contribute to the effectiveness of the water-treating system.

Filter Hookup

The two filters are also contained in tanks built of the same white cedar to minimize temperature rise. They are in parallel and valved so that either can be taken out of service and backwashed while the other is supplying the receiving sump. The filter beds consist of 52 in. of hard, carefully graded quartz sand of specified sizes and uniformity. The underdrain system has non-clogging, non-corroding, expansive-port sand valves to insure uniform distribution of wash water and collection of filtered water.

Analysis of filtered water, which contains only 0.40 to 0.50 ppm iron, is ample proof of effectiveness of the system. More tangible evidence is that in nearly a year, no deposits or scale have been discovered in piping. The plant engineer says, "She's still clean as a whistle."

Much of the credit for the success of this system must go to the completeness with which filter beds are backwashed and cleaned with both air and water. Air introduced through a system of pipe laterals with patented protective slot orifices at the top of the supporting gravel layer, literally "blasts" the iron from the sand beds while water and air rising upward in the filter tanks carries this loosened iron into washwater collecting troughs and away to the drain.

Many filters handling iron waters fail because their filter beds choke up with iron after inadequate backwashing. From experience with the L H Gilmer installation, we can recommend proper combined use of air and water for filter backwashing, infinitely more effective than water alone.

In February, 1941, with a filter-room temperature of 76 F, and well water at 57 F, filtered water, after passing through 62 ft of pipe, through the aeration plant and filters, was only 57.5 F—a pick-up of only 0.5 F.

Costs

Approximate cost of the 250-gpm water-treating system, exclusive of well and pump, was $6,000. Since no chemical is used, operating cost is practically nil. Surplus compressed air was already available for aeration and filter washing and the 5-hp motor driving the wash pump operates only 10 minutes a day. Labor cost is 20 minutes a day of one man's time charged to filter washing. Based on inspection of the system after approximately one year's service, maintenance cost is very small.

✦ ✦ ✦

Pointers on Keeping Draft Fans in A-1 Shape

▶ When a section of shrouding broke on a 450-hp, 585-rpm induced-draft fan for a large water-tube boiler in an Ohio plant last December, the resultant unbalance set up such a terrific vibration that not only was the fan damaged beyond repair, but the motor connected to it through a coupling was also wrecked, reports *The Locomotive*. Several pieces of the fan were blown out through the stack and scattered over a wide area.

So severe was the vibration during the crack-up that the concrete foundation cracked in several places, hold-down bolts were almost pulled out of the foundation, and the cast-iron pedestals and bases were broken.

Investigation showed that the accident had been caused by internal corrosion of the fan, together with high stack-gas temperatures. Many rivet heads had been eroded extensively, and the cross-sectional area of some of the angle irons at the joints, attaching the shrouding to the fan blade, likewise had been so reduced by corrosion that less than 20% of the original area remained in service.

Normally, average stack temperature was about 550 F, but the boiler-room chart indicated that these temperatures had been considerably higher prior to the failure.

Preventative Measures

To prevent such accidents to large fans, not only should they be checked frequently in operation, but they should also be examined internally at regular intervals. Here are some of the more important precautions:

(1) The fan unit should be examined internally at regular periods for corrosion and erosion, and for cracks, particularly in the hub and shrouding. (2) When an internal examination is made, all parts of the fan should be looked over for an accumulation of foreign matter that might unbalance the rotor. (3) If there is excessive vibration, the cause should be definitely determined. (4) The condition of the coupling and unit alignment should be checked. (5) Stack-gas temperatures should be kept within reasonable limits. (6) If the unit can overspeed, the driving machine should be equipped with overspeed protective devices which function within safe limits of speed. (7) A check should be made of the operation of all control apparatus for the unit to determine whether or not it is running correctly. (8) Bearings, both for driving machine and for the fan, should be properly lubricated, and bearing temperatures must not be excessive. (9) Foundations, pedestals, bases, frames, and other parts of the unit should be examined for loose bolts, cracks or any unusual conditions or defects which might cause breakdown.

Performance Test at Ford Motor Co

Good fortune for both POWER and its readers came with this article, one of the most complete power-plant test reports we have ever seen. On record for the first time, as far as we know, are these data on testing a turbine by the calibrated-nozzle method; performance of the 900,000-lb-per-hr River Rouge boiler was established by loss measurement

By W W DULMAGE, *Ford Motor Co*
and C J WALKER, *General Electric Co*

► River Rouge, No. 1 power plant of the Ford Motor Co at Dearborn, Mich., now contains three General Electric 110,000-kw vertical-compound condensing turbine-generators and one 15,000-kw non-condensing machine, all operating on 1200-lb steam. Total installed capacity of 345,000-kw is supplied by boilers rated at 3,200,000 lb per hr.

The initial high-pressure installation consisted of two steam-generating units, each rated 700,000 lb per hr at 1350 lb, 750 F, and the first 110,000-kw turbine arranged for steam reheat to 550 F at the crossover. The second installation operates at 900 F without reheat and, in addition to the 110,000-kw unit, includes a 15,000-kw non-condensing turbine exhausting at 250 lb to evaporators which produce process steam from treated makeup water.

The three 110,000-kw units have had an outstanding service record, given in Table I as a matter of general interest.

The third and last installation, the subject of these tests, consists of a 900,000-lb-per-hr steam generator rated 1250 lb, 915 F and a 110,000-kw turbine with hydrogen-cooled generators. The superheater of this boiler was originally designed for 925 F but minor changes in the baffles resulted in steam temperatures of about 915 F. Test measurement, Fig. 1, shows a curve crossing 900 F at 570,000 lb per hr output and 920 F at 900,000 lb per hr.

A complete series of tests in December, 1939, indicate that both the steam generator and the turbine-generator unit conform with guarantees in every respect. The boiler efficiency, Fig. 1, is seen to be between 87 and 88% from one-third to full load. The turbine heat rate, Fig. 8, is less than 9000 Btu per kwhr for the upper half of the load range.

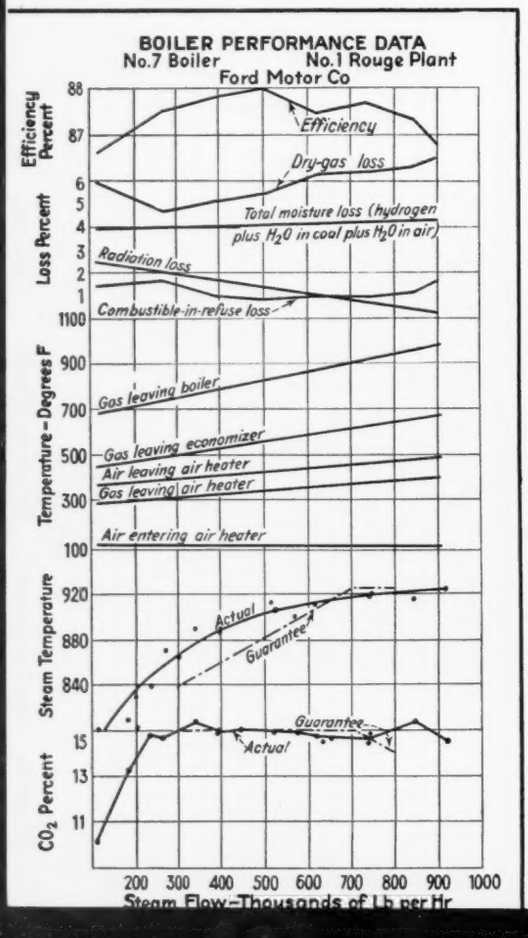


Fig. 1—Comparatively short test runs of one-hour duration give satisfactory accuracy for determining efficiency by loss measurement

11,000-Btu Heat Rate

The use of high-temperature, high-pressure steam for the last two units not only has eliminated the necessity for reheat but has resulted in high thermal efficiencies in actual operation. The 1200-lb, 900-F plant has a heat rate appreciably under 11,000 Btu per kwhr corresponding to a plant thermal efficiency in the neighborhood of 31%.

The new Combustion boiler is a bent-tube double-set unit with five drums, two superheaters, two fin-tube economizers and two plate-type air preheaters. The dry-bottom furnace, completely water cooled, is tangentially fired from four sets of five burners located at the furnace corners. The bottom burner of each set fires blast-furnace gas; the top burner utilizes coke-oven gas. The middle three burners handle pulverized coal, the main fuel of the plant. The fuel-burning equipment of each furnace also includes 12 fuel-oil burners, six on each side.

Gas is ordinarily used for starting the unit and on week ends when there is no other use for the gas. Gas, coal or oil can be burned separately or in combination.

Boiler Arrangement

The 169,000 sq ft of heating surface is distributed as follows: boiler, 24,470; water walls, 9500; superheater, 24,019; economizer, 25,200; air heater, 86,016. The furnace has a horizontal section 25.8 x 32 ft and an effective combustion space of 31,900 cu ft, designed for a heat release of 35,500 Btu per cu ft when the unit delivers 900,000 lb per hr. Furnace walls are made up of 3-in. fin tubes on 5⅛-in. centers. The dry-ash bottom consists of plain tubes.

Four boiler drums have forged shells with welded-on heads; the dry drum has a welded shell with welded-on head construction. Superheater elements connect to the dry drum by rolled and welded joints. Gas bypass dampers are provided to limit steam temperature at high ratings. These dampers are positioned by four air cylinders operated from a master controller at the instrument board. The steam temperature, however, has such a flat characteristic from 600,000 to 900,000 lb per hr that use of the dampers is not necessary over this range.

Four 2-speed forced-draft fans are rated 70,000 cfm at 100 F and 10.25-in.

wg. Two 2-speed induced-draft units are rated 260,000 cfm at 365 F, 18-in. wg at their highest speed.

Main fuel is pulverized Eastern Kentucky coal having approximately 6.7% ash, 1.3% moisture and 0.54% sulphur. Ash is removed from the furnace bottom by two screw conveyors having water-cooled shafts. This method of ash removal, developed on the low-pressure boilers, was successfully applied to the high-pressure equipment.

Evaporators Supply Factory

The last two steam generators are cross connected to supply either turbine from either boiler as well as to provide steam for the 15,000-kw noncondensing unit exhausting at 250 lb to evaporators. The latter supply steam at 180-lb for factory use supplemented by low-pressure boilers.

In testing the power equipment at the Ford Motor Co, it was found by experience that centralization of testing equipment reduced the man power required for any given test and simplified direction and control of the test crew. The idea was carried out in this case by building two test benches, one on the economizer deck and one in the forced-draft-fan room. All orsat and thermocouple potentiometer readings were made at these two tables. Six men were able to take all the readings on the boiler including optical pyrometer measurements and power consumption of auxiliaries.

Performance of the steam generator was determined by loss measurement. For a large unit such as this, loss determination is probably as accurate as a weighed-coal test and has the added advantage that comparatively short runs, one-hour duration, are acceptable.

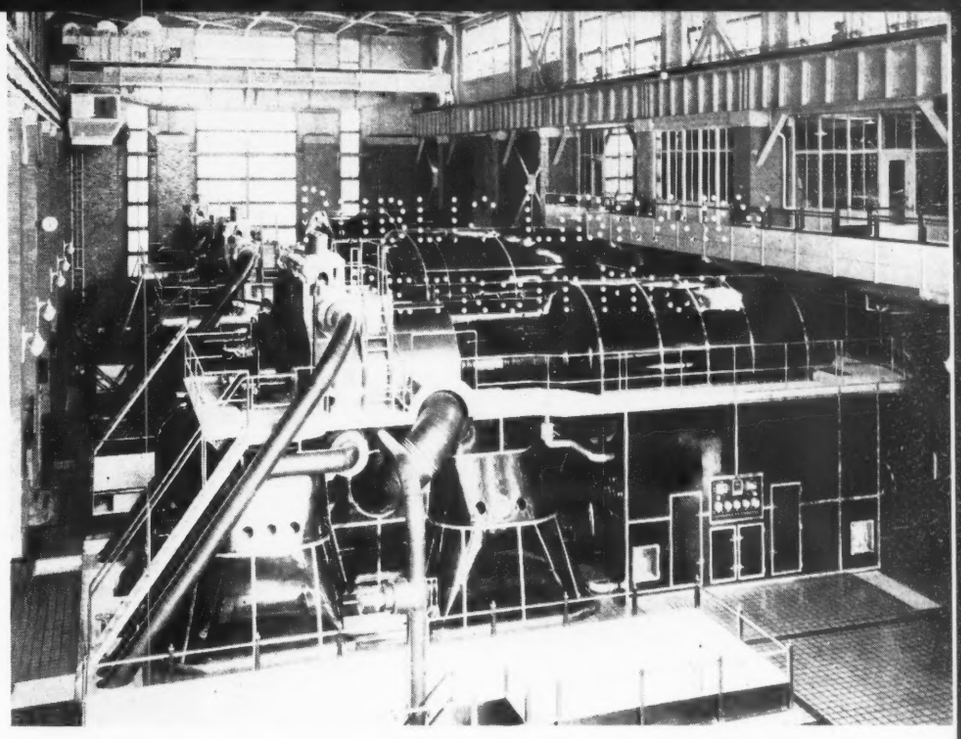


Fig. 2—Spotless turbine room showing newest hydrogen-cooled generator driven by 110,000-kw vertical-compound turbine in the foreground

Some of the measurements from which the percent losses were calculated are shown on Fig. 1. Guarantee rating of the boiler is 900,000 lb per hr but test loads were carried up to 1,000,000 lb per hr for one-hour periods with no sign of trouble in either furnace or boiler.

The vertical-compound turbine-generator unit, Fig. 2, has the high-pressure element mounted on top of the low-pressure casing, requiring a minimum of floor space. The 12-stage, 1800-rpm, high-pressure element has two valve chests connected to the main steam header by four pipes in parallel. The upper chest contains five valves, the lower chest two. All admit steam to the first-stage nozzles. The first 2-row Curtis stage is followed by eleven single stages with an extraction opening after the sixth stage.

Two short crossover pipes connect the high-pressure turbine exhaust with the low-pressure turbine bowl. The double-flow low-pressure element, also 1800 rpm, has ten single stages in each end with extraction from the crossover, the 15th and 18th stages.

The test heat cycle differed from the guarantee, shown in Fig. 3, in several respects. The tests were run with the evaporator cut out, no generator cooler in the feedwater circuit, the high-pressure heater drain flashing to the crossover heater and a surge tank floating between the flow nozzle and the deaerator. The effect of each of these

Fig. 3—Calibrated flow nozzle inserted in condensate line ahead of deaerator eliminates complication of weighed-water test without too great a sacrifice of accuracy even for important tests of large units

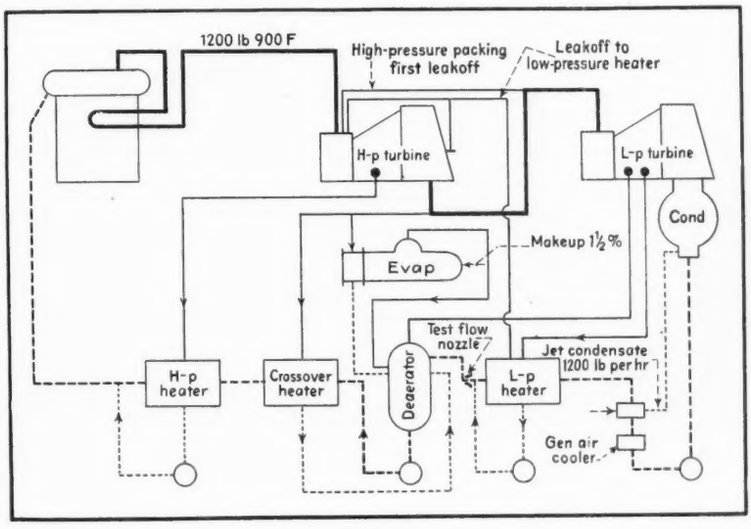
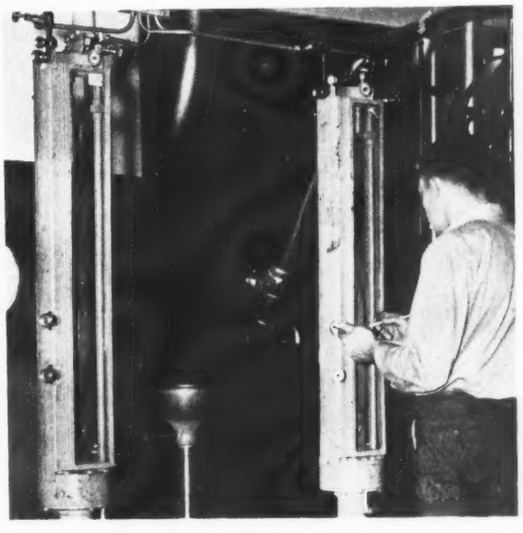


Fig. 4—Two single-leg manometers give check on head readings across nozzle with agreement within 0.06% of flow



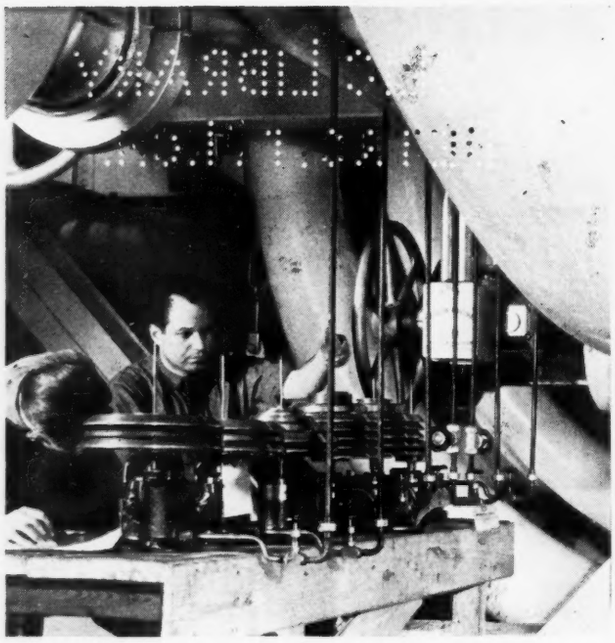


Fig. 5—Header, shell and extraction pressures measured with deadweight gages at a central point in pipe gallery

Fig. 6—Condenser pressures from eight basket tips read by one operator on these mercury absolute pressure gages

differences is small and readily calculated and the test performance of Fig. 8 has been corrected to the cycle of Fig. 3.

The two hydrogen-cooled generators are each rated 55,000 kw, 0.8 pf at 13,800 volts. The exciter is direct connected to the low-pressure turbine-generator. Both stators have double windings connected to two separate station buses. One winding of each generator is connected to each bus to maintain proper load distribution in event of trouble on one bus.

The main condensate flow was measured with a 3.640-in. x 10.03-in. flow nozzle. The nozzle was calibrated in the test section of pipe by Professor W S Pardoe of the University of Pennsylvania. The nozzle was preceded by 12 pipe diameters of straight pipe and a flow straightener made of a bundle of small pipe; it was followed by eight diameters of straight pipe. Fig. 4 shows the two single-leg mercury manometers used to measure the differential pressure. Connected to two pairs of upstream pipe taps and nozzle-throat taps, the average difference in condensate flow shown by the two separate head measurements was 0.06%.

The flow nozzle measured condenser steam flow plus low-pressure heater extraction plus any change in hotwell level. The condensate temperature rise and the bleed steam enthalpy were measured for each heater so the extraction steam quantities for the three high-pressure heaters could be calculated by the heat-balance method.

The unit was isolated from the rest of the plant for these tests and turbine seals were supplied with condensate taken from and returned to the condenser hotwell. The main condenser was checked for leakage by the condensate-resistance method and indicated leakage of 0.05% at 600,000-lb-per-hr flow was considered negligible. No leakage correction was applied in this operation.

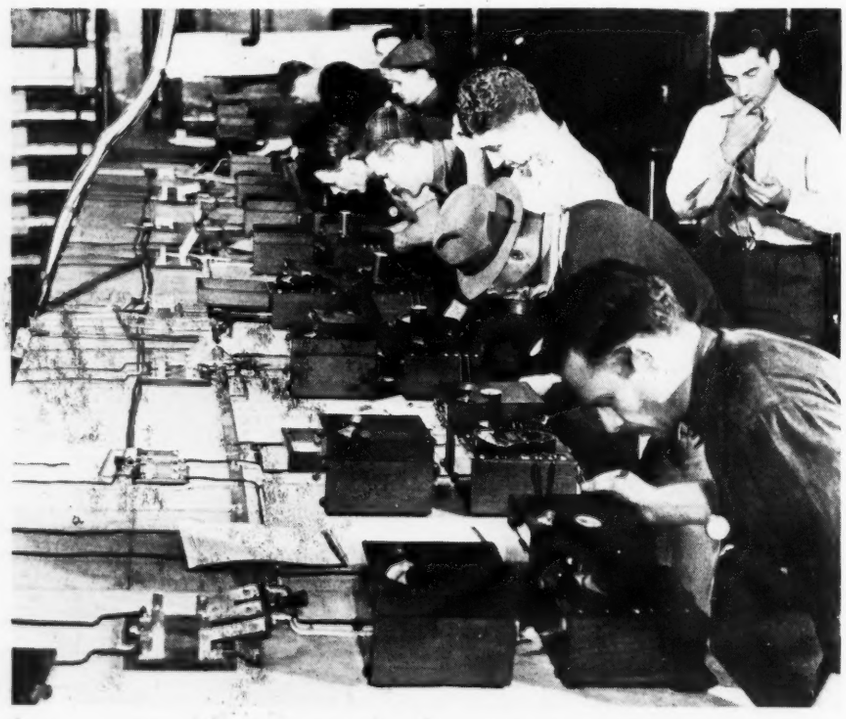


Fig. 7—A total of 1440 individual readings on the twelve wattmeters on this table establish one test load for a one-hour run

Deadweight Gages

Steam pressures were measured at the main header, valve chest, first-stage bowl, first-stage shell, low-pressure turbine bowl and in the extraction pipe to each heater. All pressures above 20 lb g were measured with dead-weight pressure gages shown in Fig. 5. A precision potentiometer measured thermocouple voltages for temperature measurements.

Pressures too low to read on the dead-weight gages were measured with

Table I—Service Record of Three 110,000-KW Units

Unit	*Started*	*Hr installed to Jan 1, 1941*	*Hr operated to Jan 1, 1941*	*Hr out no load to Jan 1, 1941*	*Hr out for repairs*	*1000 kwhr generated*	*Availability*
1	July, 1931	82,716	72,548	10,168	336 (reheater).....	3,123,147	99.6%
2	July, 1936	39,098	31,152	4,946	15 (gov valves).....	1,242,556	99.9%
3	June, 1939	13,153	10,458	2,865	None.....	372,481	100.0%

mercury manometers. Four basket-type static pressure tubes were installed in each of the two exhaust hoods at the condenser-flange level. These eight condenser pressures were measured by mercury absolute gages conveniently located on a temporary panel, Fig. 6, so one observer could take all the readings. Condenser pressure was adjusted by bleeding air into the jet suction and for most of the points shown on Fig. 8, the pressure was held within 0.03 in. of 1 in. Hg. Only a very small correction for exhaust pressure was necessary.

Thermocouples

Steam and feedwater temperatures were measured with thermocouples calibrated before and after test by the General Engineering Laboratory of the General Electric Co. Thermocouple cold junctions were maintained at 32 F in an ice bath.

Fig. 9 shows the efficiency of the high-pressure element as determined by the load-flow and enthalpy-drop methods. The good agreement between the two methods at flows above 330,000 lb per hr is evidence that measured temperatures, flows and loads cannot be much in error. The curve indicates throttle-to-exhaust efficiency based on shaft output including stop-valve and control-valve throttling losses, the exhaust loss and most of the crossover loss.

The generator-terminal output was measured by the 3-wattmeter method. Since the two generators each have two windings, four separate output measurements were necessary. Current and potential transformers were calibrated with the same instrument burden as for the tests. Selected type P3 portable indicating wattmeters, calibrated before and after test, measured the loads. Twelve wattmeters, Fig. 7, were each read twice per minute, making a total of 1440 readings for a one-hour test point.

Flow and temperature rise of cooling water for the built-in heat exchangers of the hydrogen-cooled generators were measured to determine generator losses.

Test Performance

Test and guarantee heat rate and water rate are compared in Fig. 8, corrected to the flow diagram of Fig. 3. Test performance equals or excells guarantee at all loads and averages 1.4% better than guarantee at half, three-quarter and full load. The heat rate is seen to be 8740 Btu per kwhr at about 114,000-kw output corresponding to a switchboard engine efficiency of 82.3% and a thermal efficiency of 39.1%.

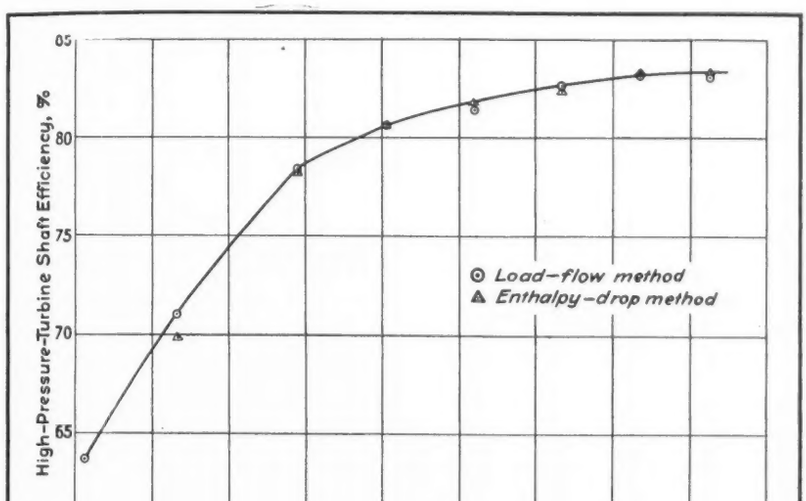


Fig. 9—Measurement of high-pressure turbine performance by enthalpy-drop method checks points established by load-flow readings closely at all loads

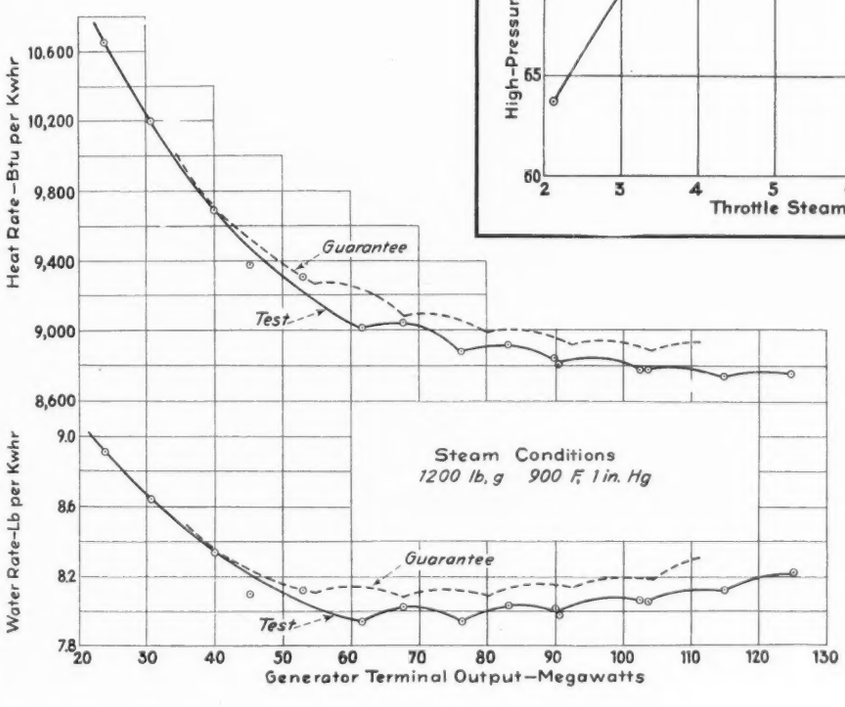


Fig. 8—Test performance of the turbine-generator betters guarantees by an average of 1¼% and reaches a best point of 8740 Btu per net kwhr throttle to switchboard

Electrical Machine Solves Heat-Transfer Problems

A roomful of electrical elements at Columbia University can be plugged in to duplicate (by analogy) almost any practical problem in three-dimensional heat flow—all the way from the quick freezing of fish to pipe insulation and boiler furnace walls. Problem answers are read directly from instruments

By PHILIP W SWAIN

Editor of POWER

▶ NEWSPAPER MEN call it an "electrical brain"—a popular name for almost any piece of electrical equipment used to determine almost anything. Whatever you call it, a remarkable electrical device, recently assembled at Columbia University, New York, does the work of a mighty good human brain in the solution of heat-transfer problems—in fact solves problems far too difficult or tedious for our best-heeled experts in applied mathematics.

The man principally responsible for this installation—Dr Victor Paschkis—was a research engineer in various European countries before he came to America in 1938. Working with H D Baker, instructor in Mechanical Engineering at Columbia, and using funds advanced by the Research Foundation (Washington, D. C.), Dr Paschkis has practically covered three walls of his laboratory in the engineering building with stacks of trays of electrical condensers and resistances, with elaborate plug boards for cross connections. To the casual observer it looks like a cross between a telephone exchange and a radio shop.

In somewhat technical language Messrs Paschkis and Baker told the story of this equipment in Philadelphia on June 20, at the national meeting of the Applied Mechanics section of the ASME. Back of their differential equations was a romantic story—and one of broad engineering interest.

This remarkable device is destined to play an important part in American engineering research—to cut into the big area of guesswork in the solution of heat-transfer problems, replacing today's guesses by measured facts. That is why engineers everywhere should know what it is, how it works and what it can accomplish.

Fundamentally, what Dr. Paschkis does is to plug in electrical quantities analagous to the thermal quantities to be investigated. He then "turns on the juice" for a specified time and measures what happens in electrical terms. These can be translated directly into the desired terms of heat transfer—thus giving the answer to the original problem electrically "set up" on the machine.

Dr Paschkis gives full credit for the original idea of solving transient heat-transfer problems by an electrical model to C L Beuken, Dutch engineer, but he has notably improved Beuken's original apparatus.

Electrical Parallel

Engineers have long noted a close parallel between steady heat flow and steady electrical flow. As a simple case, consider a metal rod insulated so heat can flow from one end to the other, but not out the sides. Keep one end at constant high temperature until a steady condition is attained. Heat will flow from the hot end of the rod to the cold end at a rate directly proportional to the difference in temperature between the two ends and inversely proportional to the heat resistance of the rod. The heat-flow equation is:

Btu per hour = Temperature difference ÷ Resistance to heat flow.

In this formula the unit of heat resistance would have to be that resistance which would permit one Btu per hour to flow with a temperature difference of one degree F.

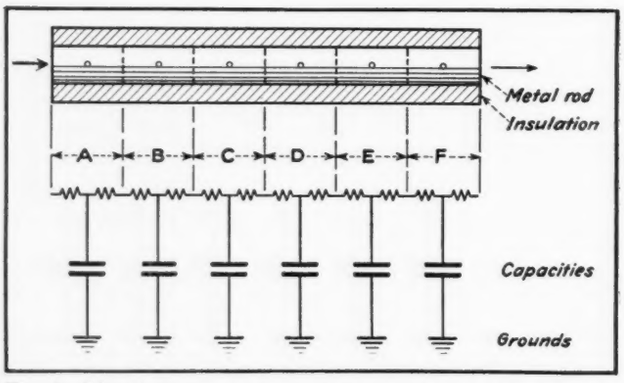


Fig. 1—Electrical setup for one-dimensional heat flow in the unsteady state. Temperature difference becomes voltage difference. Heat resistance becomes electrical resistance. Heat capacity becomes electrical capacity. Btu's become coulombs of electrical charge. Btu's per hour become amperes

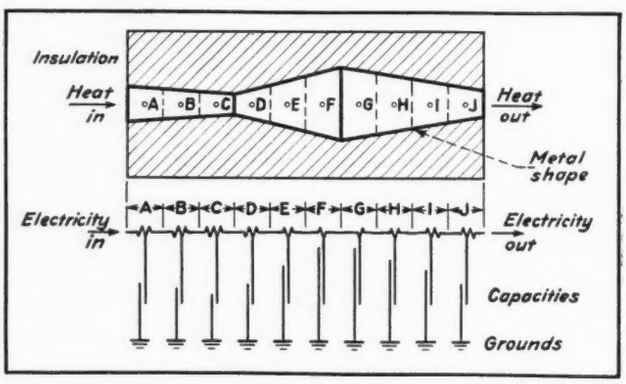
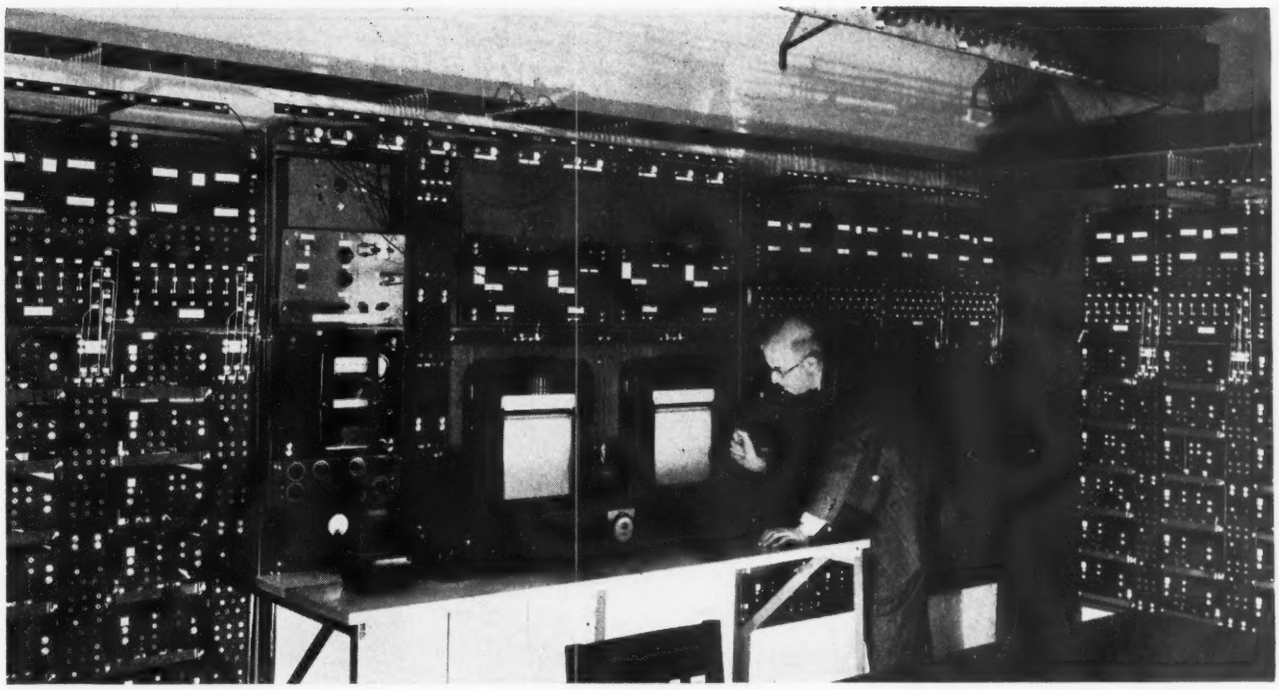


Fig. 2—Like Fig. 1, except that the metal heat path is of irregular section, so that resistances and capacities vary from one section to the next. After the setup is once made this problem is solved as quickly as that of Fig. 1 by plugging in desired dc voltage for proper time and reading instruments



Nine of the 15 sections are here visible. Note instruments and controls at center

Now for the electrical parallel—again a metal rod or wire of appreciable resistance. Apply a steady voltage across its ends and a current will flow directly proportional to the voltage and inversely proportional to the electrical resistance. The formula here is the well known Ohms Law:

$$Amperes = Volts \div Ohms$$

Since this has exactly the same form as the formula for steady heat flow, it follows that you could solve any simple heat-transfer problem of this type by setting up Ohms resistance equal to the heat resistance, applying volts equal to the temperature difference. The resulting amperes of current will be numerically equal to the heat flow in Btu per hour. Such a problem could be electrically solved in this manner, but nothing would be gained for it would be much easier to get the answer by simple arithmetic.

The task Dr Paschkis set himself started with this simple concept, but developed into something far more elaborate, complete enough to match difficult practical heat-transfer problems in which the heat flow is in three dimensions, and changing from moment to moment, and in which the body is of irregular shape and composition.

With extreme ingenuity Dr Paschkis has met these many requirements. You can send him a scale drawing of a mass of fish interspersed with refrigerating pipes. Give him the data on pipe temperatures, heat conductivity and specific heat of the fish. He will plug this data in on his switchboards, throw on a direct current of specified voltage for a specified number of seconds, read certain voltmeters and then tell you what would be the temperature of a fish at such and such a point in the mass, so many seconds after the cold was turned on.

Exactly the same technique can solve a problem of cooling molten steel in an ingot mold, heating up a backing layer of brick in a furnace wall, or the rapid-fire ebb and flow of temperatures in a diesel-engine piston head.

When heat flow is unsteady the equipment must provide for heat storage as well as heat resistance. The wave of heat set up in a cold rod by the sudden warming of one end is slowed down if the heat capacity of the rod is high. You might say that the heat has to take time out to fill up all the voids in the rod before it can reach that steady state where as much heat comes out of the cold end of the rod as enters the hot end.

This storage business is easily

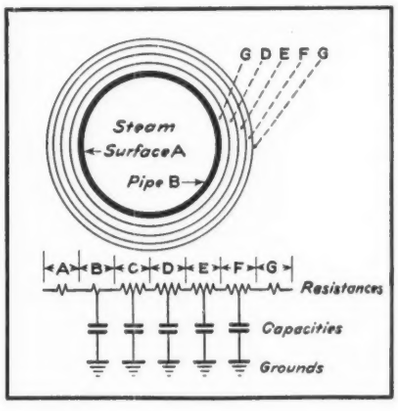


Fig. 3—Setup to determine temperatures and heat losses when a cork-insulated pipe is alternately steam heated and cooled. This model quickly checked the curves obtained by actual test on the insulated pipe

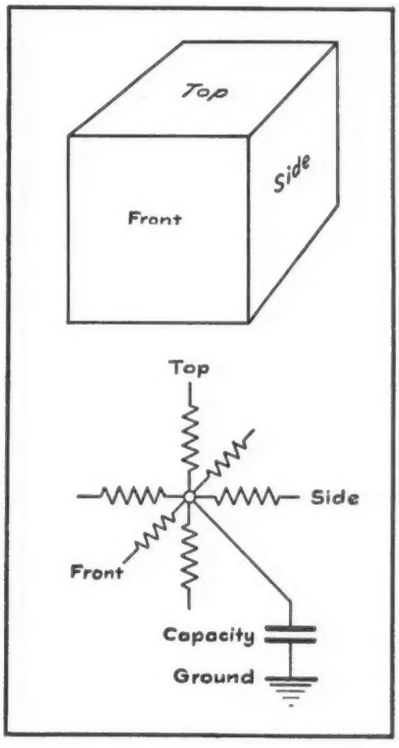


Fig. 4—For 3-dimensional flow the original heat-transfer structure must be divided into pieces of cubical or other shape. Resistance to heat flow can be represented by the three resistances and heat capacity by a grounded condenser

handled by adding electrical capacity to the circuits at the right points. Consider a simple case of straight-line heat flow in an insulated metal rod (Fig. 1). Imagine the rod arbitrarily divided into sections as shown. You know the heat resistance and the heat capacity of each section, and can set these up on the machine as the corresponding electrical resistance and electrical capacity. The capacity, concentrated at the middle of each resistance, is obtained by plugging in a condenser of proper size.

Plugging in Resistances

For each section of the rod, plug in electrical resistance in ohms equal to the heat resistance of the section measured in the unit already described (unit resistance is that which allows one Btu per hour to flow with a temperature difference of one degree F across the section). Set up the electrical condenser capacity in farads equal to the heat capacity of the section in Btu per degree.

When all these resistance and capacities are connected in proper order as shown, apply to the two ends of the network a direct-current potential difference equal to the temperature difference between the ends of the rod. Apply the voltage for a time in *seconds* equal to the time in hours for which the heat flow is to be investigated. The charge transmitted in ampere seconds will equal the Btu flowing into the hot end of the rod, or out of the cold end. The instantaneous voltage read at any point in the circuit will determine the temperature at that point in the rod.

Fig. 2 is one step more difficult. Here the insulated rod has an irregular cross section. That means that each section has a different resistance and a different heat capacity. For equal lengths the thin sections will be high in heat resistance and low in heat capacity, and the thick sections the reverse. These are set up electrically as shown, with corresponding variations in electrical resistance and electrical capacity. These variations are roughly indicated in the sketch. (Large condenser capacity is represented by large overlap of condenser plates.) Once set up on the switchboard, the problem is solved (as in Fig. 1) by applying the proper d-c voltage for the predetermined time. Electricity trickles along the rod, pausing to "fill up" the various condensers. Ammeters measure "heat flow." Ampere-hour meters measure Btu. Voltmeters measure temperatures.

Fig. 3 illustrates one type of practical problem in which Dr Paschkis has electrically repeated some tests previously run on the West Coast with a cork-insulated pipe intermittently heated by steam. This problem has practical importance because a pipe heated half the time loses considerably more than half the heat that would be lost from a pipe heated all the time, particularly if the heating intervals are short.

Dr Paschkis set up the proper resistances and capacities for the pipe and the imaginary layers of the cork. Since he worked from steam temperature inside to air outside he set up at *A* and *G* electrical resistances only (no capacities) representing the boundary heat resistances (from steam to metal and from cork to air). His elec-

(*Continued on page 170*)

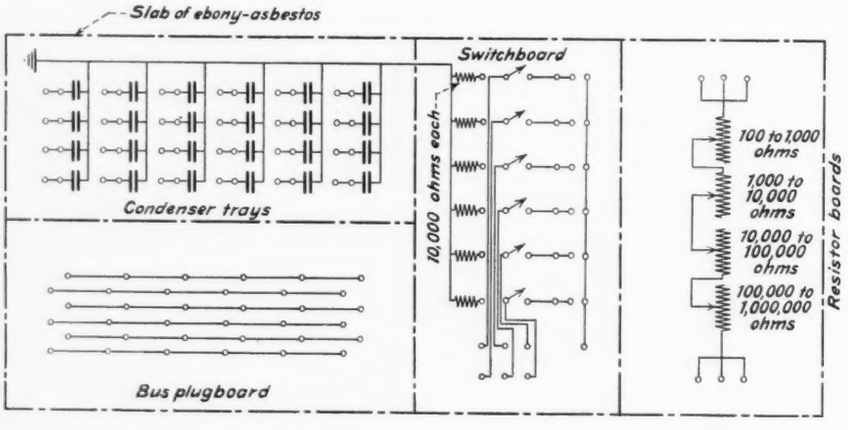


Fig. 5—Wiring diagram of one of the 15 sections. On this, property resistance and capacity are plugged in to represent one section of the original heat-transfer structure

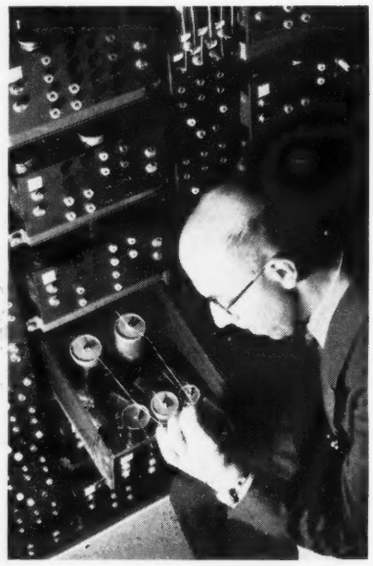
OUR GAIN

This is one of those strange cases where America has profited directly from the sad events in Europe. Originally connected with the Vienna Institute of Technology, Victor Paschkis worked in various European countries from 1922 to 1938, in the latter year coming to America to escape an intolerable situation on the continent.

He worked for two years in Connecticut and Pennsylvania, then started looking for an opportunity to apply his specialized knowledge of heat transfer. Seeking suggestions and advice, he called on my good friend George Stetson, editor of *Mechanical Engineering*. Stetson sent him to me. I sent him to Dr Jacobus and Mr Kohler of Babcock & Wilcox Co, who in turn suggested a university research connection at Columbia.

At Columbia his ideas won the favorable attention of Dr Charles Lucke, then head of the M E Department (retired July 1, 1941) and well known consultant on heat-transfer problems. Dr Lucke appointed a special committee (representing the Departments of Physics, Metallurgy and Electrical Engineering) to investigate the technical soundness of the proposals. Upon this committee's favorable report he arranged for a laboratory for Dr Paschkis, and the Research Corporation donated funds to finance the equipment.

Dr Paschkis had in mind a radically improved form of the heat-transfer electrical "model" first developed by C L Beuken, Dutch scientist with whom Dr Paschkis had worked shortly before coming to America. With the help and advice of various scientists at Columbia and elsewhere, he designed and assembled his equipment and demonstrated its accuracy, practicability and adaptability. It now stands ready to solve difficult heat-transfer problems submitted by industry. P W Swain



Dr Paschkis examines one of the 90 trays of condensers. The complete "model" contains 525 condensers and thousands of plug connections

Tests Show Effect of Suction Head on Condensate Pumps

Investigation reveals source of many common troubles; curves show limits of submergence and impeller speed beyond which trouble may be expected*

By HOLLIS T WALDO
Engineering Department
Warren Steam Pump Co

▶ CONDENSATE PUMPS extract liquid from a vessel under vacuum, such as a steam-turbine condenser or the vacuum element of an evaporator system. Today, most of these pumps are centrifugals and because of operating conditions they present problems somewhat out of the usual run.

Although different feedwater systems impose varying problems on the condensate pump, the main consideration is getting water from condenser to boiler because ordinary rules of centrifugal-pump design do not apply. Special factors entering the picture are:

(1) The intake end of the suction pipe is under a high vacuum, (2) pump must be below hotwell condensate level, (3) pump must respond quickly to sudden and varying loads on the turbine, (4) water in the hotwell is close to vaporization temperature due to low vacuum in condenser, and (5) on ships, rolling and pitching must be considered.

A centrifugal, or for that matter any pump, cannot produce a vacuum as high as that existing in most power-plant condensers. Therefore, to get condensate to flow from condenser hotwell into pump suction, the pump must be placed below in order to operate under a certain submergence or static suction head. Space limitations of most installations, particularly those on ships, make it necessary to keep the distance between pump-impeller eye and hotwell water level to a minimum.

To investigate the effects of submergence on condensate-pump operation, we built the testing set-up shown in Fig. 1. An elevated open-head tank connects to a vertical vacuum tank corresponding to a condenser hotwell. Water flows into the vacuum tank and from there to the suction eye of a vertical centrifugal condensate pump which discharges into the head tank. A steam-operated ejector maintains desired vacuum in the hotwell. A mercury column measures hotwell vacuum and a pressure gage indicates pump discharge pressure.

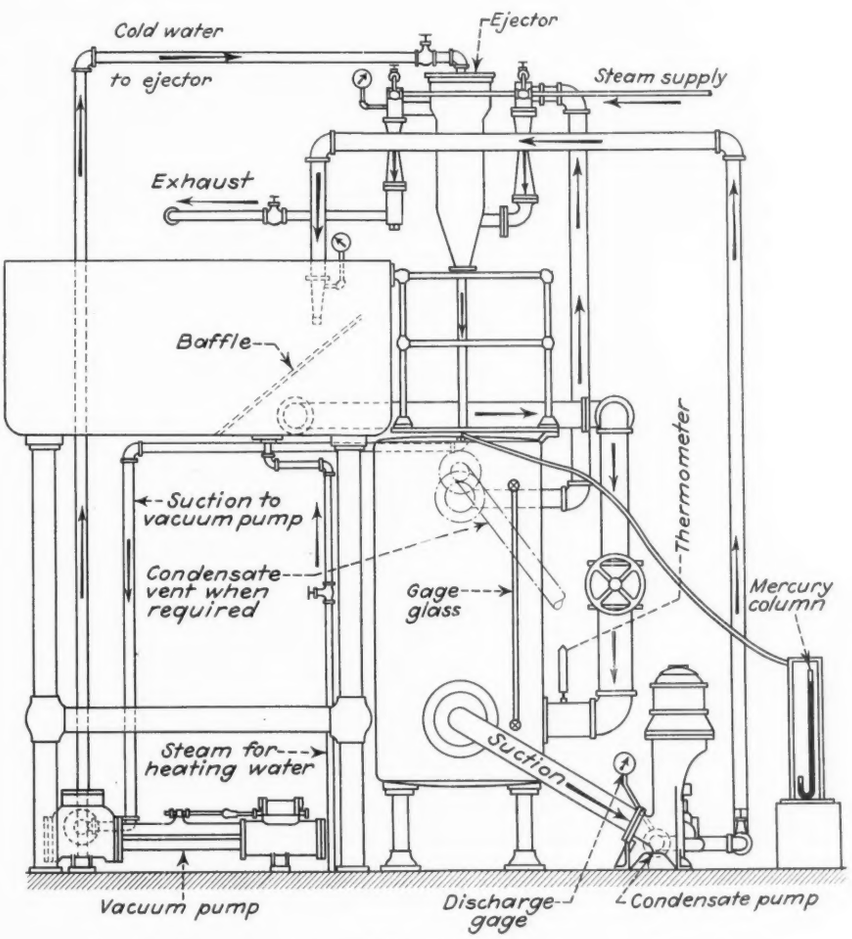


Fig. 1—Laboratory set-up used in making the tests on condensate pumps

Duplicates Service Conditions

A steam line going to the bottom of the elevated tank heats water to desired temperature in the hotwell, measured by a thermometer at the hotwell intake. With this set-up we were able to duplicate closely service operating conditions ranging from atmospheric to 29-in. vacuum in the hotwell, with submergence of pump suction up to 48 in. Pump capacity was measured by a pressure gage on a calibrated nozzle on the end of the pump-discharge pipe. Power input to the pump was also measured.

Many tests on various sizes of single-suction pumps all showed the same typical characteristics, Fig. 2. The curves for free suction, that is, with the hotwell vented to atmosphere,

* This article is based on paper awarded third prize in a recent Hydraulic Institute Prize-Paper Contest.

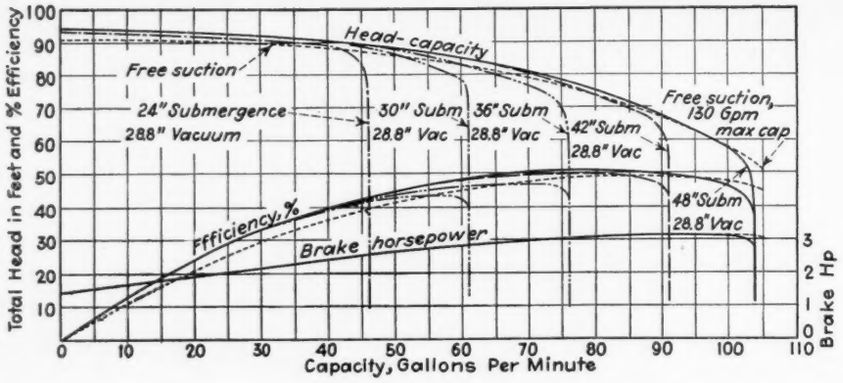


Fig. 2—Performance of 1730-rpm condensate pump with 10-in. impeller

follow closely the curve for operation under all other conditions, up to where pump capacity fails to increase when discharge head is decreased.

For example, take the case of 28.8-in. hotwell vacuum and a submergence of 24 in. on the pump suction. Pump operation was normal up to a discharge of 40 gpm against 90-ft total dynamic head. Efficiency and power of the pump were also normal. Beyond 40 gpm, head fell off rapidly and at 47 gpm the pump broke down and its capacity failed to increase with decreased head. With submergence stepped up to 36 in. and hotwell vacuum held at 28.8 in., pump capacity increased to 72.5 gpm against 75-ft head before breakdown.

Results

In studying and analyzing this problem, we came to the conclusion that the following factors make up the total suction head or submergence: (1) Difference between condenser vacuum and vacuum produced by condensate pump, (2) head required to cause flow (velocity head), (3) pipe friction losses, (4) entrance losses, (5) radial velocity head, (6) loss due to whirl at impeller entrance, and (7) head necessary to prevent vaporization.

As it was impossible to segregate each of these elements and calculate them separately, we used an empirical method. The seven factors can be divided roughly into those due to impeller rotation and those connected with getting the water to the impeller eye. Therefore, a figure for the first group was obtained by multiplying the impeller-eye diameter in inches by the impeller speed in revolutions per minute. Water velocity in feet per second in the suction pipe was taken as representing the second group of factors. We plotted these for several sizes and types of pumps operating with suction submergence of 12 to 48 in.

Correlation of these data was so good that curves for operation at the different submergences could be drawn, Fig. 3. These curves appear to indicate a natural upper limit for the product of impeller-eye diameter and speed, which is drawn in the figure.

Next we took the observed test data (upper-limit points on curves, Fig. 3) and the radial velocities at the impeller eye, and plotted points on the basis of 28-in. vacuum as referred to a 30-in. barometer, indicating limits of speed for various pump capacities and suction submergences. Here again we found the correlation so good that curves could be drawn, Fig. 4, representing the top limits of speed for different pump capacities and submergences.

From these curves it is evident that a slow-speed pump is better adapted to condensate service than a high-speed one. For example, the 1750-rpm pump with 11-in. suction submergence was better than the 3500-rpm unit with 48-in. suction submergence. With suction submergence of 48 in. the 1750-rpm pump is good for maximum discharge of 380 gpm compared to less than 80 for the 3500-rpm pump.

At the right, Fig. 4, there are plotted correction factors to take care of vacuum above 28 in. With assumed vacuum of 29 in. and 44-in. submergence, capacity limit of the pumps drops below a horizontal line running through the intersection of the 29-in. vacuum, and 48-in. submergence lines. Under these conditions, 1750-rpm pump capacity would drop to 280 gpm, and that of the 3500-rpm pump to 40 gpm.

With these two sets of curves, Figs. 3 and 4, we can now determine the size of suction required and thus the size of pump and the maximum speed at which it can operate. When these are known we can then consider the total head against which the pump must operate, its characteristic curves and other factors entering into pump design, such as the number of stages.

These curves also answer many of the difficulties that operating engineers experience with condensate pumps. For example, assume the pump, Fig. 2, is installed to deliver 80 gpm against a total head of 75 ft and a submergence of 42 in., with a vacuum of 28.8 in. in the hotwell. If, when the pump went into service, head on the impeller eye dropped to an equivalent submergence of 32 in. because of friction loss in suction piping, then the pump would deliver only about 65 gpm.

On the other hand, where submergence is low, use of high-speed pumps must be avoided. If trouble is being experienced with a given pump, exchanging it for a slow-speed unit and larger suction piping may solve the problem. A condensate pump may be satisfactory when hotwell vacuum is 28 in., but may lose capacity if vacuum is increased to 29 in. Such a condition might develop from the wide temperature difference of condenser circulating water in summer and winter.

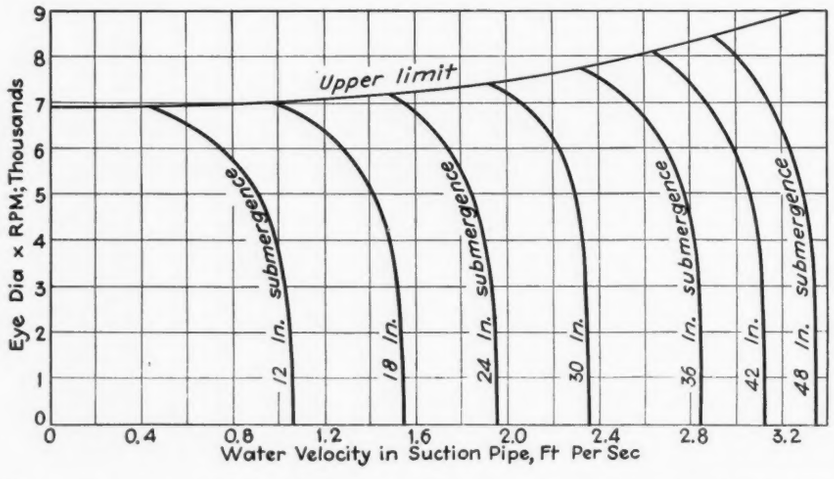


Fig. 3—Curves show relation between impeller-eye diameter times speed and water velocity in suction pipe at different submergences

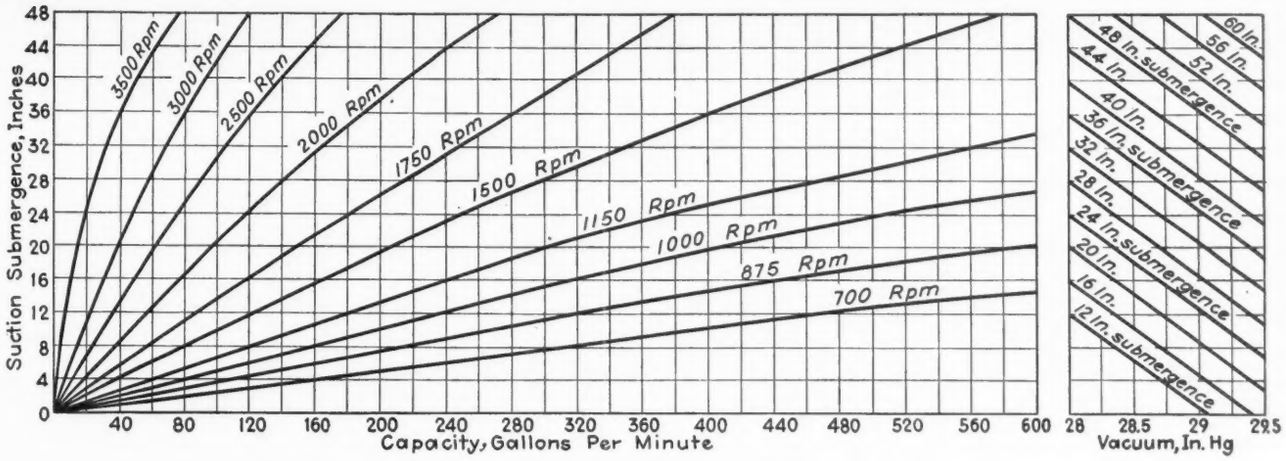


Fig. 4—Impeller-speed limits for different pump capacities and suction heads

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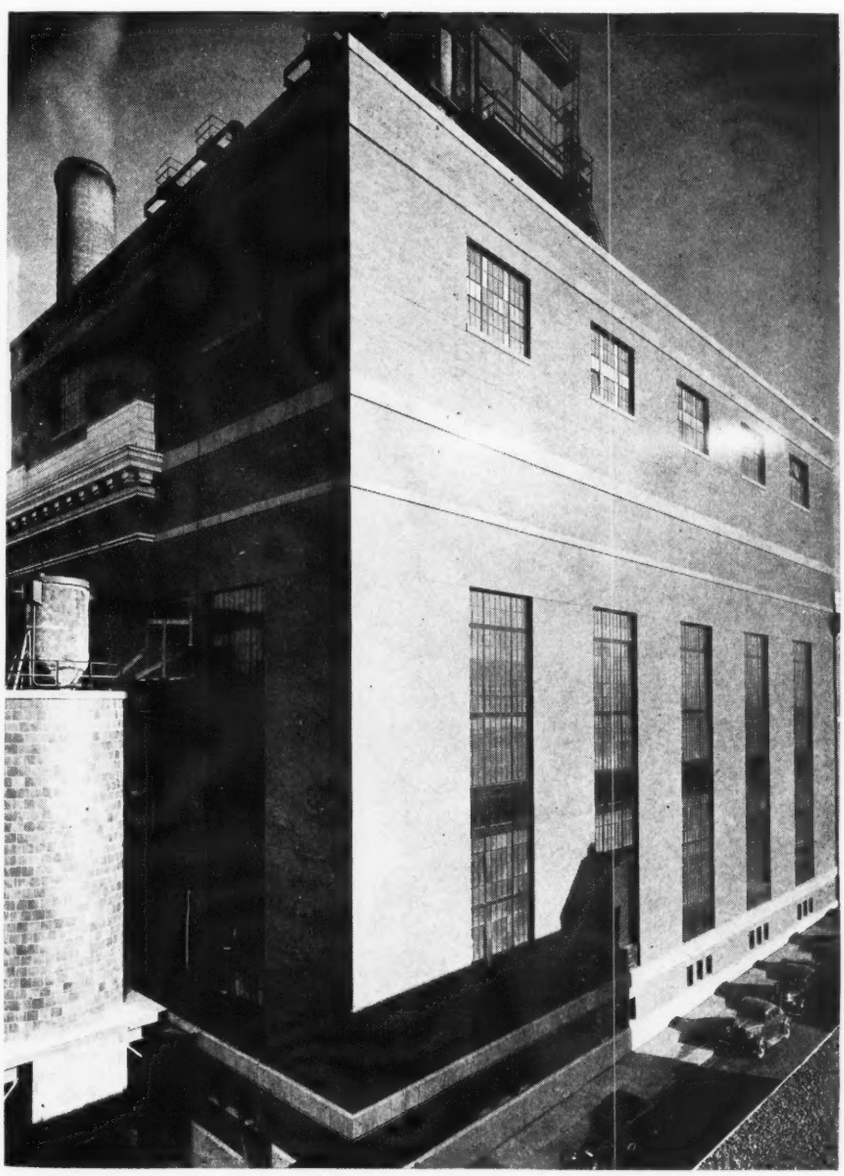
Capacity in Boston Area Rises to Meet Defense Loads



▶ At L Street Extension, latest addition to Boston Edison's largest steam plant, South Boston, engineers are now installing a second 1200-lb topping unit rated at 18,750 kw for operation early in 1942. The Combustion Engineering boiler will generate 542,000 lb per hr; General Electric is supplying the turbine-generator unit.

The extension now houses a 25,000-kw Westinghouse topping unit; total capacity of L Street at present is 225,000 kw. Firm capacity of Boston Edison, including 75,000 kw under New England Power Association contract, is now 460,000 kw. With 58,000 additional scheduled for 1942, which includes a first unit for the new Mystic Station, the company is in a strong position to meet all expected power demands.

The photo shows the new extension. In the left foreground is a collecting tank for cinders, dust and flyash gathered by the electrostatic precipitator on the roof of the building.

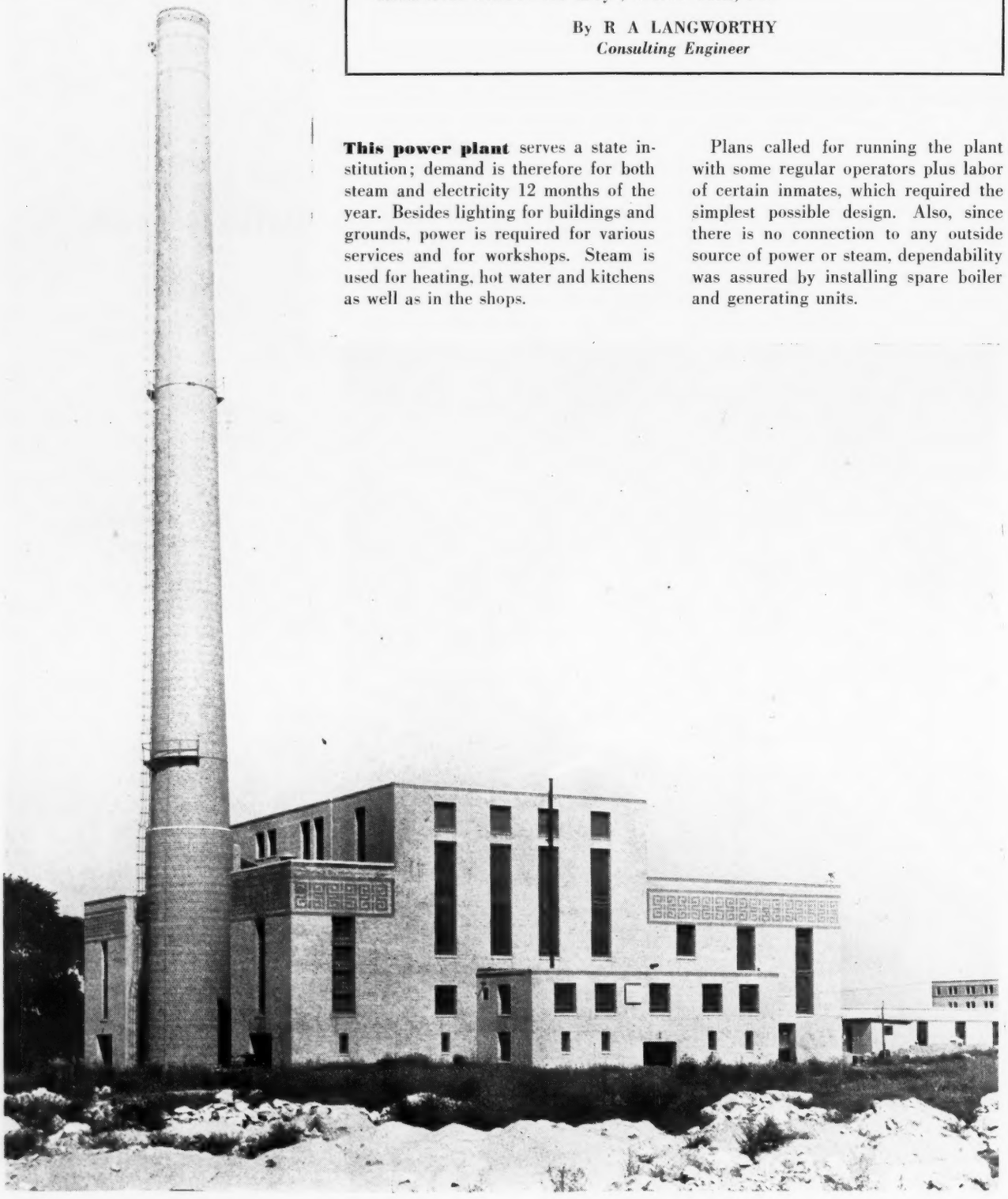
Building an Institutional Power Plant

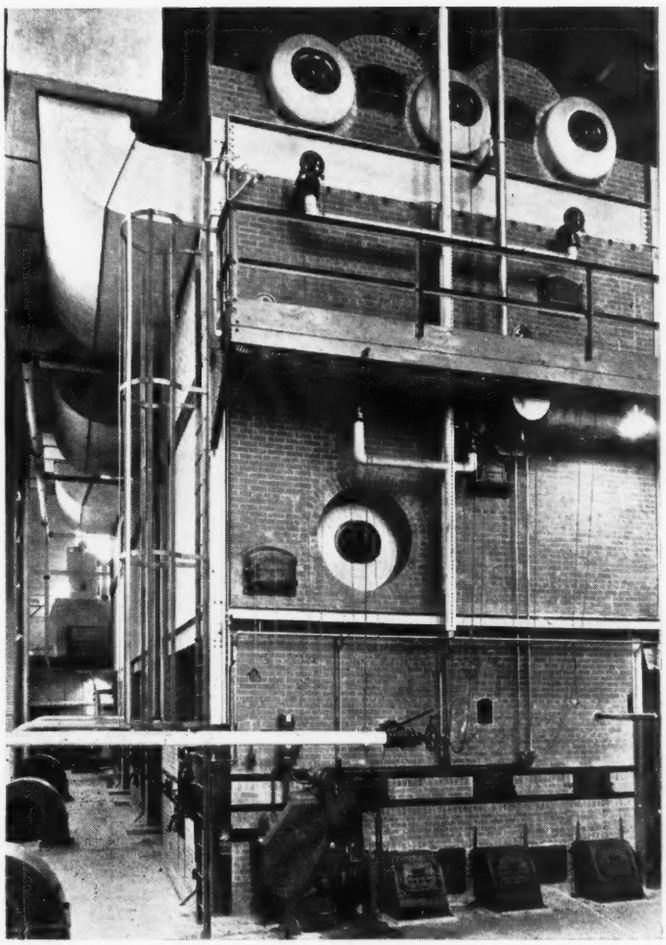
Photos shows what was done, words tell why it was done to provide an economical, dependable plant at Pennsylvania State Industrial School for Boys, White Hill, Pa.

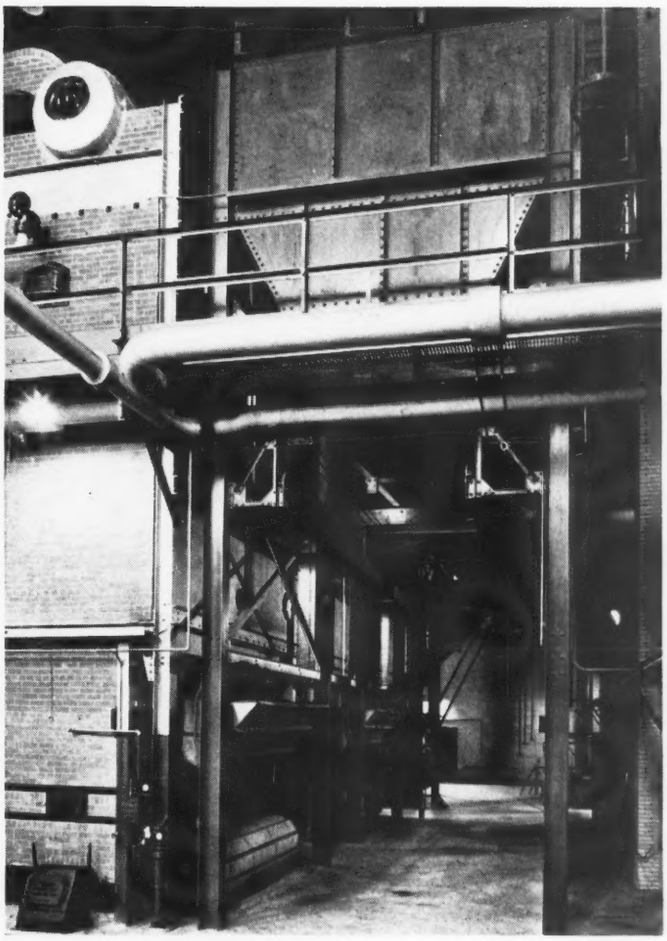
By R A LANGWORTHY
Consulting Engineer

This power plant serves a state institution; demand is therefore for both steam and electricity 12 months of the year. Besides lighting for buildings and grounds, power is required for various services and for workshops. Steam is used for heating, hot water and kitchens as well as in the shops.

Plans called for running the plant with some regular operators plus labor of certain inmates, which required the simplest possible design. Also, since there is no connection to any outside source of power or steam, dependability was assured by installing spare boiler and generating units.

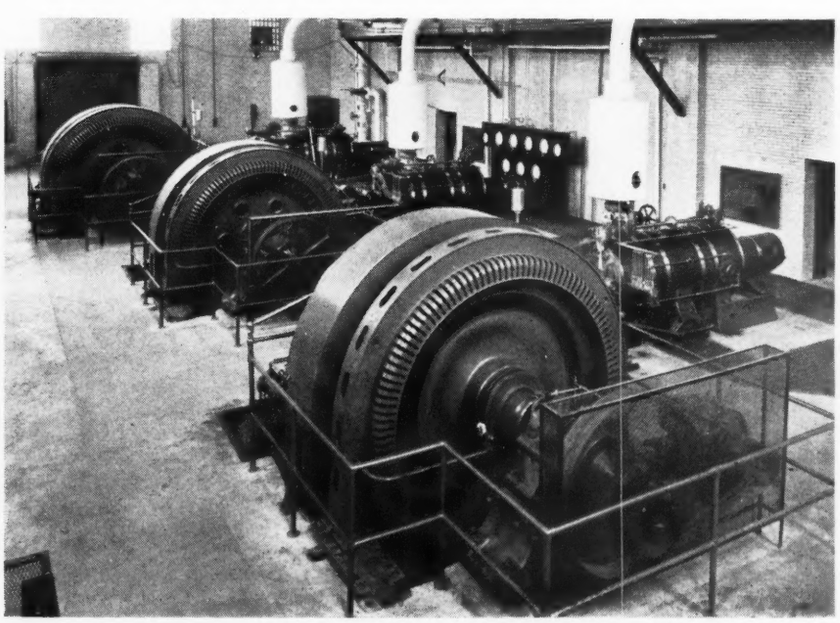






Total steam load, including power-plant use and all losses, averages about 68,000 lb per hr during winter months. In this type of plant, it is good practice to operate the boilers at moderate ratings. Considering these factors, engineers selected three 6000-sq-ft, 4-drum, bent-tube boilers to operate at 200 lb per sq in., 100 F superheat. Two units will carry the winter load at about 160% rating, conservative in view of the liberal stoker area.

Stokers are forced-draft, traveling-grate units burning No. 3 Buckwheat. Natural fuel for this region is anthracite coal obtained from mines only a short distance away from the plant. Ample stoker grate area allows a moderate rate of combustion per sq ft, which insures easy operation, good efficiency and low-cost refractory maintenance. Draft is furnished by a radial brick chimney 200 ft high and 9 ft inside diameter at the top.



Electrical load is complicated by the fact that the many buildings to be served are scattered over quite a large area. This factor made it reasonable to use underground distribution at 2300 volts and to place a substation in each building.

An analysis of electrical requirements showed that the average day load would be between 600 and 750 kw, night load between 250 and 300 kw. To meet these demands, we selected two 350-kw and one 600-kw generating units. This gives a flexible arrangement, for maximum load can be carried with either the 600-kw or both of the 350-kw units. One of the smaller machines will carry night load and probably the load on Sundays and holidays.

To take care of probable future expansion, space is provided in the engine room for another 600-kw unit. With the

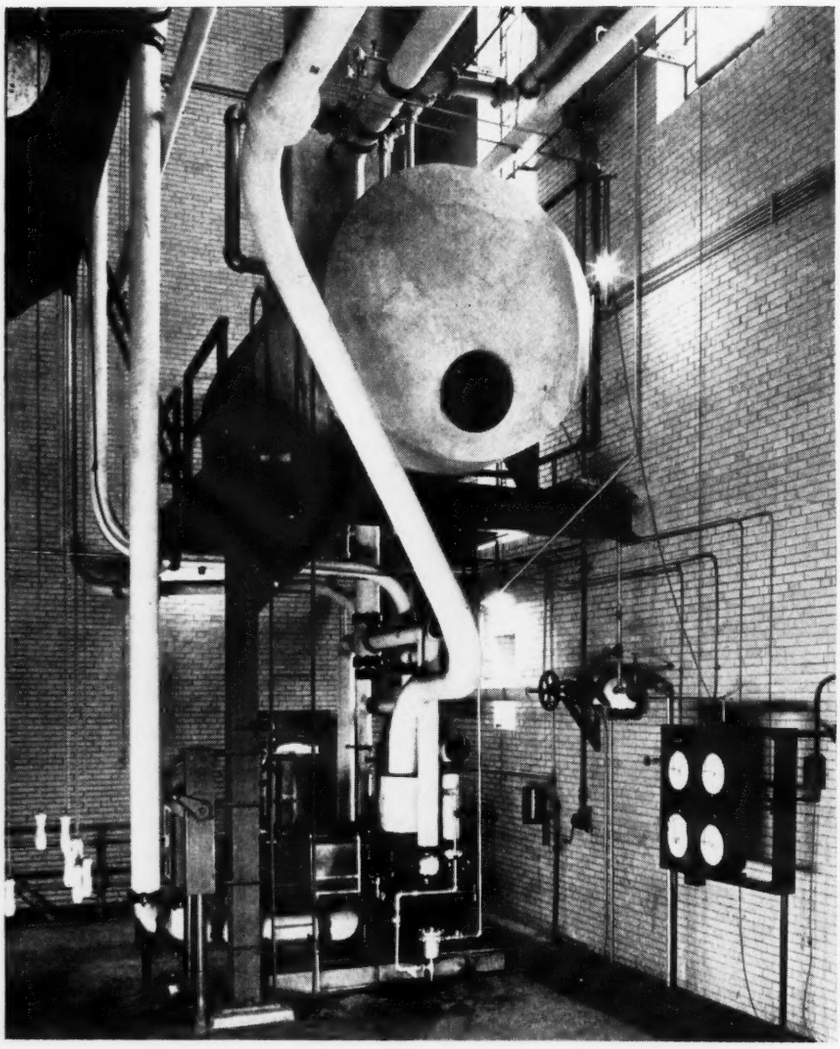
four machines, any future load can be handled efficiently.

We chose non-condensing Unaflow engines because they are economical and have a very flat water-rate curve. It was impractical to obtain condensing water except at prohibitive expense. Character of the steam load and characteristics of the engines are such that very little steam is wasted at any time, which made it attractive to use the Unaflows non-condensing.

For plants of this type, we believe that the engine-driven unit is the best solution. It is a simple machine to operate and does not require any special ability on the part of the operators. With reasonable maintenance it will run for years without trouble.

Coal can be received either by railroad or by truck. In either case, coal is dumped into a receiving hopper under the siding track. Coal cars are dumped directly from hopper bottoms, trucks are backed up over the grating to be unloaded.

From the bottom of this hopper a reciprocating feeder supplies a pivoted bucket carrier. This elevates the coal to a belt conveyor that discharges by a traveling tripper to a 300-ton overhead bunker. Gates on the bottom of the bunker supply a traveling automatic weighing larry, which in turn discharges into the hoppers over the stokers. This provides a simple efficient system arranged for convenient operation.

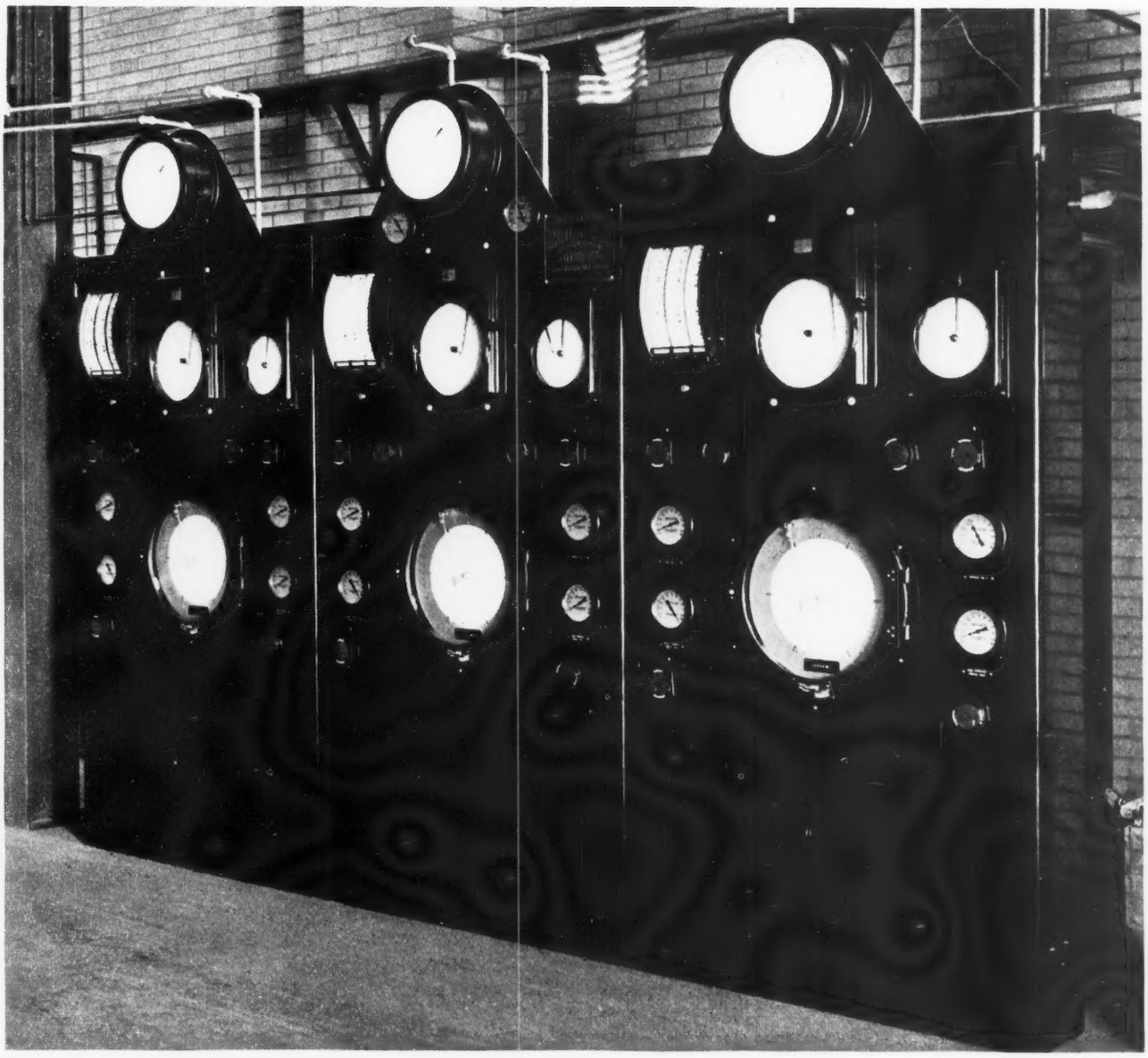


A cubicle switchboard takes care of the three generating units, station services and ten outgoing feeders. The board has the usual oil switches and instruments. All connections are through lead-sheathed cables leading to the various machines, and the outgoing circuits are carried in a vault under the rear of the board in special transite compartments. Two of the panels in the board control the series lighting systems for the Institution.

The feed heater was installed at sufficient height to give proper suction head on the feed pumps, one of which is motor-driven and the other turbine-driven. The photo above shows the pumps, below the deaerating heater, and the duplicate loop system of feed piping and necessary regulators.

A steam-jet ash conveyor was installed after consideration of the type of plant involved, its size and the small amount of ash produced. The conveyor discharges into a tile storage bin; trucks can be backed up under the bin to remove the ashes.

Water treatment was installed because a limestone subformation meant water from any source would have to be treated, and water character varied with the season of the year. Our choice was a hot-lime process softener with filters. All water-treating equipment is housed in a separate room with all parts readily accessible and proper arrangements made for chemical analysis from time to time.



Meters and instruments include automatic combustion control, CO_2 recorders, draft gages, pyrometers and meters on all steam services such as engine leads, steam (both high- and low-pressure) to buildings, steam to boiler feed, and meters on water lines. It should be easy to keep a complete performance record. The plant has not been placed in full operation as yet because the Institution had not been occupied. It was started up, however, last September to tune up various pieces of equipment and to instruct operators. Preliminary operation was highly satisfactory.

Principal New Power Equipment

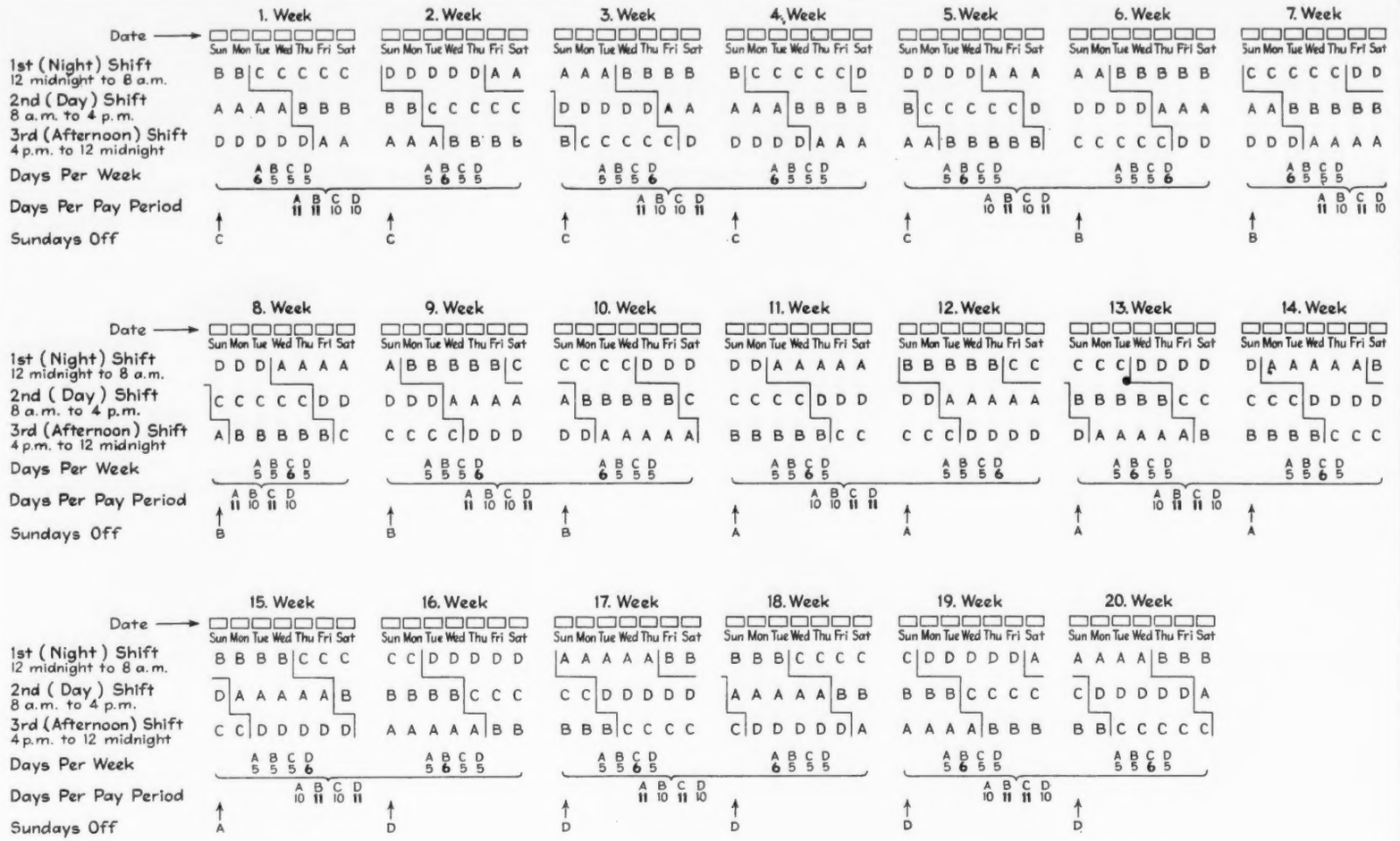
Pennsylvania Industrial School for Boys, White Hill, Pa.

R A LANGWORTHY, CONSULTING ENGINEER

Boilers, 4-drum, bent-tube	E Keeler Co
Superheaters	E Keeler Co
Stokers, Coxe traveling-grate	Combustion Engineering Co
Refractory arches	American Arch Co
Forced-draft fans	Green Fuel Economizer Co
Stack, 9 x 200 ft	Rust Engineering Co
Coal elevator, Peck carrier	Link-Belt Co
Coal-handling equipment and bunkers	E P Dandridge Co
Ash-handling equipment, steam jet	Frederick Engrg Co
Combustion control	Hagan Corp
Deareating heater	Cochrane Corp
Water-treatment plant	Cochrane Corp
Boiler-feed pumps	De Laval Steam Turbine Co
Soot blowers	The Bayer Co
Pipe covering	Armstrong Cork Co
Steam flowmeters	Cochrane Corp
Valves	Chapman Valve Co
Pressure-reducing valves	Mercon Co
Steam engines, Unaflow	Skinner Engine Co
Generators, 2300 volts, ac	Electric Machinery Mfg Co
Switchboard	Roller Smith Co
Transformers	Maloney Electric Co
Crane	Roeper Crane & Hoist Works
CO_2 recorders	The Hays Corp

Convenient Shift Schedule

For 4-crew set-up, any number of men per crew



Crew A	Crew B	Crew C	Crew D
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6

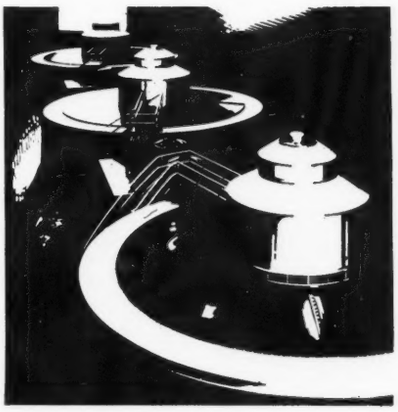
NOTE THAT the three *shifts* are listed in the extreme left hand column; and that the four *crews* are designated by the letters *A*, *B*, *C*, and *D*. The hours designated by the letter *A* on the chart show exactly the hours and shifts crew *A* will work during the entire 20-week period, etc. Every man works five days in a row and then is off at least 48 hours, after which he changes shift. Over each period of 20 weeks every man has 5 Sundays off; over the same period every man works five extra days, totalling 105 shifts in 20 weeks. Over each period of 20 weeks every man has five pay days with 10 days pay and five pay days with 11 days pay, if he works full time. No relief men are required. Shift runs for 20 weeks then repeats without change.—*Chart submitted by courtesy of Timken Roller Bearing Co, Canton, Ohio.*

A DEFENSE DIGEST

Trends, troubles, achievements, shortcomings, gossip and sidelights of the National Defense Program, with particular reference to industry's job of production, in which the power engineer is a key man

Power-shortage headlines have many people thinking that stringent curtailment of civilian power use is not far off. First, came the announcement from the Federal Power Commission that 16 utilities, the TVA and Carolina Aluminum Co have pooled their steam facilities to pull TVA out of an embarrassing situation brought about by record low-water conditions.

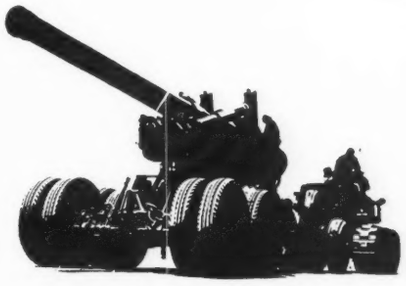
Every power engineer knows that in this particular case the problem is not one of insufficient capacity—the hydro



units are there but they aren't "firmed up" by steam reserve to take care of subnormal rainfall. The result has been a lot of loose talk about power shortages and curtailment of non-defense energy use.

Secretary Ickes, taking up the power situation as a convenient cudgel, is proposing rationing of power, national daylight-saving time, cutting down on display lighting, etc. Actually, Federal Power Commission Chairman Olds has been holding straight-talking conferences with utility representatives to warn of greatly enlarged demand for electric power over that predicted only a few months ago. Instead of the 3½-million kw which defense production was expected to require, new estimates indicate the possibility of 10 million kw being needed within the next few years. Obviously, this program will interfere with "business as usual."

Criticism of low production by



newspaper correspondents reflects growing attempts by various government agencies and departments to pass the buck. The news comments overlook the problems involved in getting under way on entirely new designs and types of war equipment. They also fail to grasp the magnitude of the task.

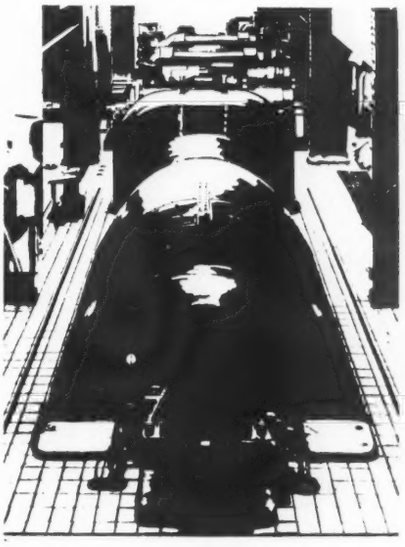
The Army and Navy, not OPM, are responsible for determining the needs of the defense program. While the Navy was a going outfit operating on a vast scale before the present emergency, the Army had a skeleton organization of officers, most of whom had no adequate preparation for handling the huge program of design and production that has been tossed in their laps. Moreover, the Army's target has shifted rapidly. A case in point is heavy tanks—designs are still being revised because of recent battle experience. Newspaper stories should be examined in the light of technical factors which few reporters and columnists understand.

If deliveries are tight on power equipment for your particular need, perhaps you can pull with profit a leaf from the book of the machine-tool industry, where used machine tools have played an important part in starting production sooner. Listed as immediately available are motors, transformers, air compressors, synchronous condensers and power-plant auxiliaries as well as turbines and boilers. If you can't get deliveries on new equipment perhaps used units will save a few dollars and many weeks.

Recall of skilled men who have been drafted requires a comparatively simple but very definite procedure. First, the employer must be able to prove that a large part of his business is directly and indirectly essential to the defense program; second, each skilled man's case must be stated separately, accurately and in full detail on the employer's letterhead. The request should be mailed to the Adjutant General, United States Army, Munitions Building, Washington, D. C.

The present record energy output can be increased 20% if industry gears itself to 24-hr-per-day, 7-day-per-week operation, said Charles W Kellogg, president of the Edison Electric Institute, at the 9th Annual EEI Convention last month in Buffalo. Mr. Kellogg, who also serves as chief of power for the OPM, stated that the electric utilities had ample reserve capacity to meet requirements of the national defense program.

Capacity of central stations is about 30% above present peak loads, according to Mr Kellogg, and he asserted that "any allegation of a power shortage is unwarranted," with the possible exception of one or two drought-seared sections dependent mainly on hydro installations. The OPM, however, has disavowed Kellogg, and has called the situation serious, due mainly to rapidly expanding aluminum production.



Riley Side Dump Stokers under your boiler will give you

These statements by Riley Side Dump Stoker users prove it

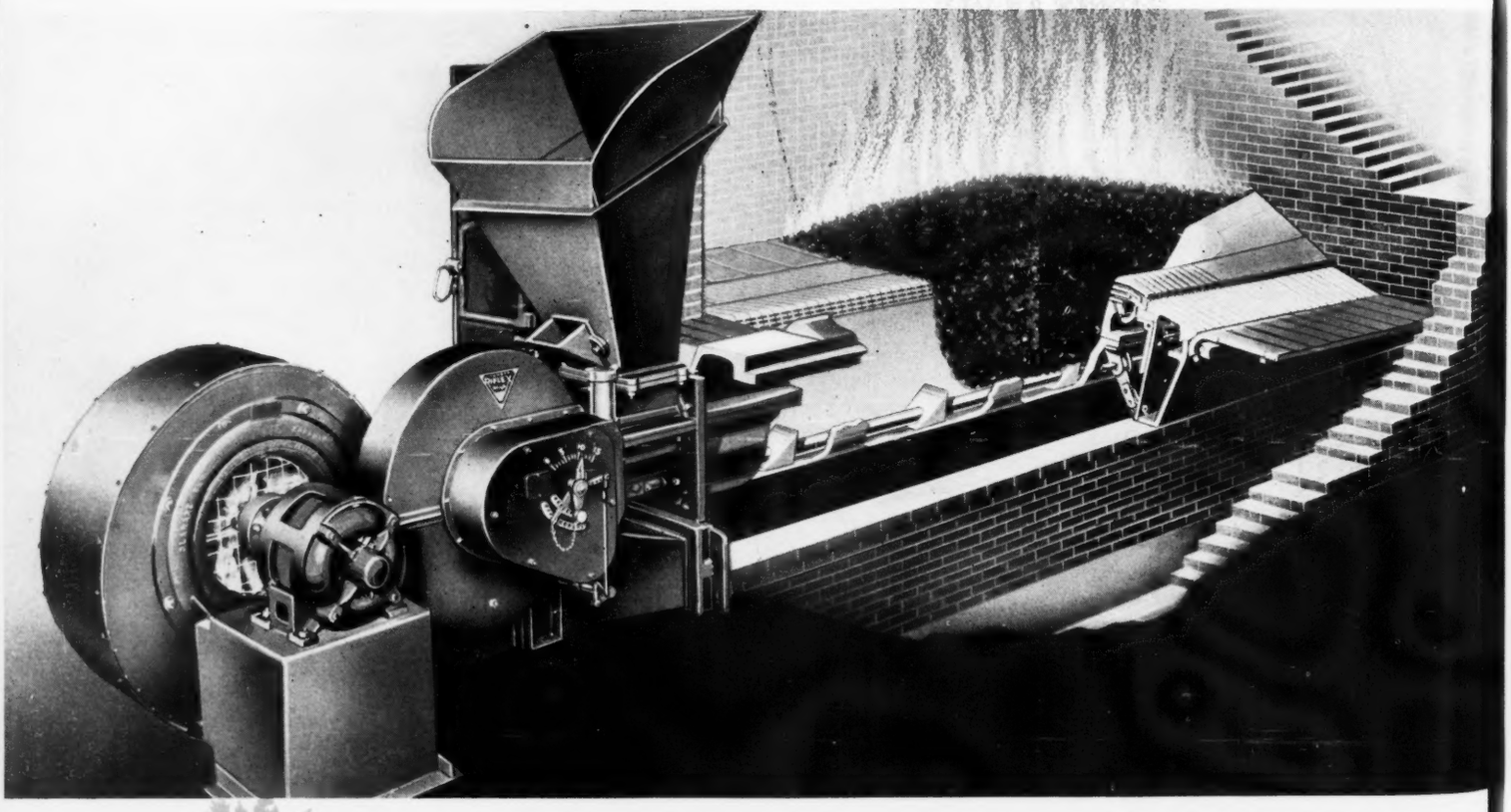
"Our chief trouble was in maintaining steam pressure. We had two boilers, one 150 and one 100 H.P. and after installing Riley Stokers we were able to shut down the 100 H.P. and the stokers easily carried the overload."

Adams Laundry, Omaha, Nebraska

"Before using this stoker, we always used two boilers, but since have been able to pull our load on the one equipped with this stoker."

Pet Milk Co., Denmark, Wisconsin

"This stoker replaced hand firing and permitted us to step up the capacity from 14,000 ft. load to 21,000 ft. load." *Dept. of Highways, Springfield, Illinois*



TRADE MARK Rx REGISTERED

RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Seattle Baltimore Richmond Denver St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta Memphis New Orleans

It will pay you to visit modern Riley Installations

the added steam necessary to meet defense loads —

"We increased our steam output by installing these stokers so that we are running three of the four boilers and have made the fireman's task so much easier that we have no labor difficulties now." *Lewis Mfg. Co., Walpole, Massachusetts*

"The stoker was installed to increase boiler capacity to take care of heating new additions to our factory. It has performed to our satisfaction."
The Jaeger Machine Co., Columbus, Ohio

"With these stokers increasing the rating from a maximum of 120% with hand firing to 225%, the load can be satisfactorily met."
Gaede Silk Co., Paterson, New Jersey

and at the same time these stokers will pay for themselves through savings in fuel and labor

"We have cut our monthly coal bill in half."
McClaskey, Inc., Wheeling, West Virginia

"The Riley stoker has surely made us money in many ways."
Crystal Laundry, Toledo, Ohio

"Our saving of coal is approximately 25% and the saving in labor, 50%."
Appleton Woolen Mills, Reedsburg, Wisconsin

"The saving last year over the previous year amounted to $3749.00. This saving has more than paid for the cost of installation."
Sheriff Street Market & Storage Co., Cleveland, Ohio

A Riley engineer will gladly visit your plant without charge. Just write us.

A survey of your power plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs

COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR-HEATERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS

before purchasing Boiler or Fuel Burning Equipment

Welding Speeds Defense

Welding steel supports for a mobile overhead crane in one of the Westinghouse Steam Division's new shops, part of a nine-million-dollar defense plant expansion. Westinghouse turbine shops, on 24-hour operation, are not only working on two and a half million hp of central-station and industrial turbine orders but also are turning out seven million more for naval vessels

Huge 39,000-kva waterwheel generator yoke being welded in the tank and plate shops of Allis-Chalmers Mfg Co, Milwaukee. This 50,000-lb piece, approximately 38 ft, 8 in. in outside diameter, illustrates the magnitude of work that can be handled. The new welding positioner in use here, said to be the largest of its kind, not only can be rotated but can be tilted to any angle position from horizontal to vertical. Starting, stopping, reversing or speed changing are continuously under control of the operator through a portable pushbutton station

THE OLD CHIEF

IX—"Drummers"

Ninth in a series by William Doran, chief engineer, Essex County Sanatorium, Windsor, Ontario. Writing of the inspiration of the past, he has captured much of the human side of engineering that lies beneath the maze of power-plant costs and the wavy lines on paper disks

The old-time drummer exercised his personality more than his slide rule

▶ THE OLD-TIME "DRUMMER" is no more —his place on this earth is now taken by a "district sales representative," a streamlined be-slide-ruled specialist who knows an awful lot about very little. I think perhaps the Old Chief would have appreciated him very much, in the same way a genuine horse lover would admire a modern automobile.

There was a time when "the man from the trade house" knew all about everything and would sell you anything you wanted. He exercised his personality more than his slide rule and what he lacked in data he more than made up in fraternity pins, experience and cigars.

I will never forget a lesson I learned from the Old Chief in respect to salesmen in general. It was at a time when we were very busy in the plant. An untimely and exasperating retubing job was on our hands and as usual the Old Chief was in the middle of things, superintending every move and putting something of himself and his cunning into every tube rolled into place.

During a lull in the proceedings an office boy came in with a card. The Old Chief glanced at it and called me over. "I wish you would go down to my office and talk to Abe for awhile. I can't leave here."

I glanced at the card. It showed the name of a supply house and the name of its representative—Mr Henry Lincoln—known to all and sundry as "Abe." "Listen, Chief," I protested, "I'm busy as the dickens and there is nothing we want from Abe now. Why not have the office boy ask him to excuse us this time?"

The Old Chief scratched his head for a moment, then said, "Just a few months ago we sent for Abe to help us straighten out a mess we were in. I was grateful for the help and service he gave me then and I am under an obligation to him for calling on me today. So go down and talk to him—if he wants to come out here and see me, rules or no rules, it's OK with me."

Before that I had never thought of salesmen in the light of my obligations to them. I had come to accept as a matter of course their willingness to undertake all kinds of research work for me, to help me in the preparation of my estimates. Since then, experience has taught me to use their specialized knowledge more and more, and to appreciate it more and more.

They Resemble the Product

The Old Chief once remarked that salesmen usually resemble the product and the type of firm they represent. "I don't mean," he said, "that 'Spike' Thompson looks like a flowmeter or that 'Abe' looks like a gate valve. What I do mean is that I have seen fellows bound in here, like a ray of sunshine, full of flattery and backslapping, then make extravagant and illogical claims for some mysterious nostrum manufactured by the Never-Heard-Of Oil Co, Inc, or the Clear Smoke Chemical Co. Well, those people are usually just like their product — mysterious and illogical."

I once asked the Old Chief if he resented the inroads salesmen made on his valuable time. He said that engineers were more guilty of wasting salesmen's time and that he seldom talked with a salesman without learning something of value. He resented only one thing in salesmen—their mistaken idea that all engineers enjoy listening to risqué stories. He told me that he had, out of politeness, been forced to laugh three times on one day at the story of the "nervous bride and the pullman porter," that happened to be going the rounds at the time. What he did very much like to hear was good news of the health and progress of old friends, news of the various engineering associations and what they were doing.

It is almost as hard to keep a young salesman from knocking his competitors as it is to keep a small boy away from the circus. The youthful salesman thinks that if he does the knocking gently, by innuendo, by telling what one of his customers told him, he is quite innocent of such a crude thing as knocking.

I once asked an experienced salesman his opinion of a rival firm. He replied that they made a high-class product, but that he thought his firm was better. I liked his answer.

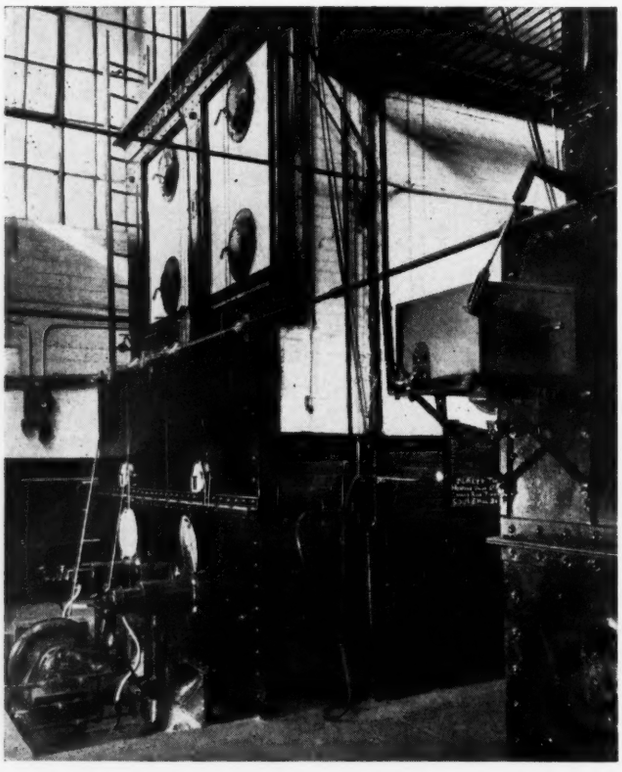
Members of the Staff

In his daily rounds of the plant, the Old Chief would make notes to consult various salesmen on their next visits, just as if they were members of his own staff, and I believe he regarded them as such. Perhaps we should all be very kind to salesmen and their human foibles, because the next generation of this tribe may be some inhuman cross between a lithograph machine and a movie projector, and we may wish we had the old "Wind Bags" back with us again.

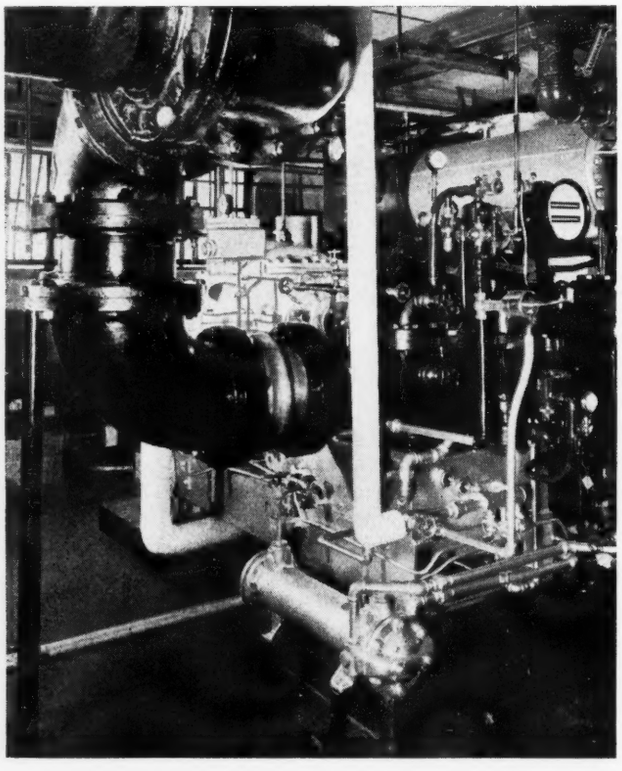
Exhaust Steam Conditions Candy Plant

Low-pressure-turbine drive for air-conditioning compressor pays out quickly for Sweets Co of America, makers of the famous "Tootsie Rolls"

By J G BERGER, ME, *Consulting Engineer, Newark, N. J.*



Conversion from hand to oil firing and addition of combustion control doubled boiler output and increased efficiency



Low-pressure turbine drive (foreground) for centrifugal air-conditioning compressor (rear)

▶ BY INSTALLING a turbine-driven centrifugal compressor using exhaust steam, instead of a motor-driven unit using purchased power, the Sweets Co of America was able to cut air-conditioning costs at their Hoboken plant enough to pay out the added investment in less than two years.

To the Sweets Co, makers of the famous "Tootsie Rolls" and other nationally known candies, air conditioning is a necessity. It makes it possible to maintain quality and rate of production regardless of weather conditions and to eliminate the summer slump in output common in the days before air conditioning. Thus, when the Sweets Co took over, in 1938, a 4-story building with basement in Hoboken, to add to their manufacturing facilities, one of the first steps was to plan for air conditioning. Preliminary estimates indicated that at least 100 tons of refrigeration would be required to maintain satisfactory conditions on the two floors where production centers.

Original Plant

The building housed an existing power plant, consisting of two B & W Stirling boilers (2500 sq ft, handfired) and two Erie-Ball, 18x20-in., 200-rpm engines driving 200-kw General Electric dc generators. When called to make a survey of the situation, our consulting organization faced three basic questions: (1) Could this existing plant be adapted to the power needs of the Sweets Co? (2) What must be done to put the plant in first-class operating shape? (3) What system of refrigeration would meet the air-conditioning needs and fit best into the power-plant heat balance and the general economic picture?

Investigation showed that with stoker or oil firing, permitting operation at 200% rating, one boiler and one engine-generator could supply dc power and process-steam requirements. In addition, steam capacity would be adequate to supply a steam-driven refrigeration compressor. However, installation of a motor-driven compressor would bring electrical load above capacity of one engine-generator. This meant purchasing power, or operating both generators, which would leave the plant without standby capacity.

This preliminary study definitely established the wisdom of utilizing the existing power plant and it was accordingly reconditioned and modernized.

Boiler settings were modified for oil and two Indiana rotary burners were installed on each boiler, automatically regulated by a Brookes combustion control. The engines were rebored and pistons fitted with new rings and all other necessary mechanical repairs and adjustments made. These steps increased both boiler and engine efficiency and practically doubled boiler capacity.

When the matter of air conditioning was considered further, four general schemes of operation appeared possible: (1) a motor-driven compressor using purchased power, (2) a steam-driven compressor using live steam, (3) a turbine-driven compressor using exhaust steam, and (4) an absorption system using exhaust steam. In each case, of course, the conditioning unit and distribution equipment would be the same; comparison was restricted to the refrigeration apparatus.

Selecting the Equipment

The motor-driven compressor offered lowest first cost while the turbine-driven unit, fitting perfectly into the power-plant heat balance, offered lowest operating cost. When final prices had been obtained, the cost of a complete installation, including turbine-driven compressor, came to about $4000 more than for a similar system using a motor-driven compressor. This differential included the added cost for a larger cooling tower to handle the turbine condenser as well as the refrigerant condenser. Since estimated savings in operating cost appeared sufficient to pay out the added investment quickly, the turbine-driven unit was selected.

Refrigeration equipment, installed early in 1938, consists of a Carrier centrifugal compressor, rated at 140 tons, driven directly by a 153-hp Moore turbine, designed to operate at 5-lb-gage throttle pressure and 26.6 in. vacuum. Liquid refrigerant from the compressor evaporates in a tubular multipass cooler, chilling water for use in the air washer. The refrigerant compressor is of similar construction. A water heater, supplied with exhaust steam, tempers the air in winter months.

Chilled water from the compressor unit (or warm water from the heater, in winter) goes to the main air washer, located in the basement not far from the compressor equipment. Outside air, introduced through louvres in adjacent window openings, mixes with return air before entering the washer. In the washer, the air is cooled or heated, dehumidified, or humidified, depending on the season, and partially cleaned. Air from the washer passes through filters for final cleaning and then through reheating coils (supplied with exhaust steam) for final temperature control.

A single large fan supplies conditioned air to the second floor and another supplies the third floor; two smaller fans supply conditioned air to a conveyor and to the offices on the third floor. Supply ducts rise through a stairwell at the east end of the building and then run along the second- and third-floor ceilings. Adjustable-diffusion outlets distribute air to the conditioned spaces. Return air flows from the rooms through grilles in the stairwell partition. All windows in conditioned spaces are glass block.

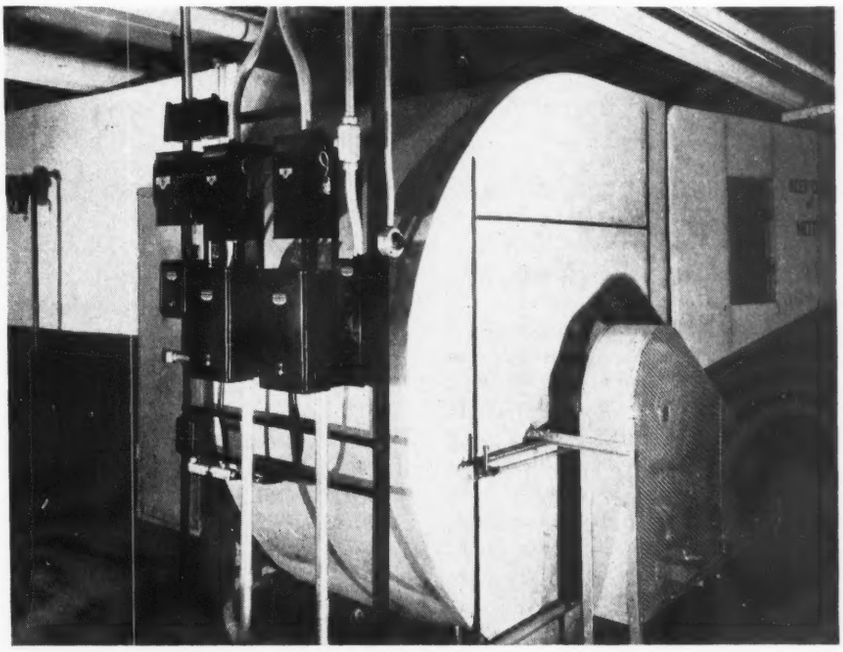
A Carrier dewpoint control regulates outside- and return-air dampers, the summer water-cooling equipment, and the winter water-heating equipment. A thermostat in the return from each floor controls bypass dampers at each large fan and thermostats on the east and west sections of each floor control volume dampers in the respective branches to prevent overcooling or overheating as the sun moves from east to west throughout the day. Separate thermostats, independent of other controls, provide desired conditions in the president's office and in the general offices.

This system maintains an average summer temperature of 77 F in the conditioned spaces and holds relative humidity to about 50% when temperature is 77 F in summer and 72 F in winter. Guarantees are based on a maximum outdoor dry-bulb temperature of 95 F coincident with a maximum wet bulb of 75 F; winter maximum is taken as 0 F. During winter months, the system will temper air supplied to the conditioned spaces to 80 F, thus supplementing the existing cast-iron radiation system.

Condensing water flows first through the refrigeration condenser, then through the steam condenser and finally to the new forced-draft cooling tower on the roof. Powered by an 8-ft aluminum-alloy-bladed Jeffrey fan, belt-driven from a 10-hp Louis Allis motor, the tower is guaranteed to cool 530 gpm from 111 F to 86 F, when wet-bulb temperature is 78 F.

Since installation, this system has had three full seasons of operation. It is possible to figure roughly the saving made over motor drive by estimating hours of operation and average load and applying the proper purchased-power rate. During 1938 and 1939, the saving amounted to about $2500 per year and in 1940, with more operating hours because of overtime work, the saving came to about $3000.

Recovery of exhaust steam, that would otherwise blow to atmosphere in summer months, reduces city-water makeup. Addition of a motor-driven compressor would have increased the small ac load carried on the utility lines to a point where a transformer vault would have been required. Growth of ac load has just now made this vault installation, at a cost of $3500, necessary. Thus, installation of a turbine-driven compressor can be credited with postponing this expense for three years (worth about $600 at 5% interest).

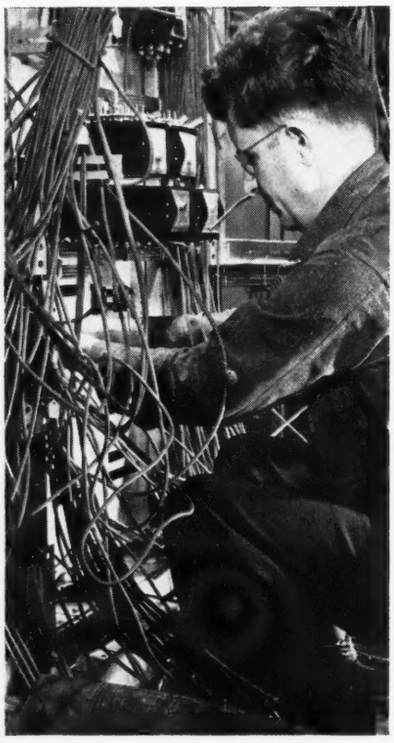


One of two large fans which, with two small ones, distribute air from the conditioning unit, at left, to the duct system supplying the working spaces

So You're Puzzled About Electric-Conductor Insulations

If you've been wondering just what type of insulation to use for a particular application, you will welcome this "according-to-Hoyle" discussion of the 19 types recognized and specified by the 1940 National Electrical Code

By M M BRANDON
Associate Electrical Engineer, Underwriters Laboratories, Inc



Many types of wire and insulation are needed to meet the many demands of modern service

▶ THE TABLE on pages 285 and 286 of the National Electrical Code mentions 19 different types of wire and cable insulations. These types are in addition to the special wires such as Types AF and CF fixture wire mentioned in the Code for special applications. For simplicity, fewer types of wires and cables are desirable, but the demands for special characteristics in electrical conductors have been such that wire and cable manufacturers have been practically obliged to produce in quantity the types contained in the Code. Scores of special wires and cables manufactured are not of sufficient interest to warrant inclusion in the Code.

On the chart shown on the next page, Type R is the old familiar Code type, Figs. 1 and 2, a rubber-covered wire with a so-called code-grade insulation over the copper conductor and a fibrous covering treated to have moisture-resistant and flame-retardant characteristics. This general-use wire has probably been produced in greater quantities than all other types combined—billions of feet are made yearly. It is limited to an operating temperature of 50 C (122 F).

The next type of wire mentioned, the moisture-resistant Type RW (Fig. 3), is the same as Type R except that the rubber insulation is compounded to absorb very little moisture. It is a comparatively recent development in rubber-covered wire and is used in wet locations where lead-covered insulated wire would otherwise be necessary. Although this wire is relatively new, rubber compounds of similar character have been used for many years on submarine cables. Maximum operating temperature is 50 C (122 F).

Performance-grade rubber, Type RP wire (Fig. 4), is suitable for general use at a maximum operating temperature of 60 C (140 F). The chief difference between this grade and Type R is in the compounding of the rubber to permit continued operation at a temperature of 60 instead of 50 C. This is a relatively new product in so far as the National Electrical Code is concerned, but a similar grade of compound has been produced by the rubber-covered-wire industry for many years.

Heat-Resistant Wire

Heat-resistant grade, Type RH (Fig. 5), recognized for a maximum operating temperature of 75 C (167 F), represents the best that rubber chemists today can offer in the way of compounding. For some time it was known as "superaging" material because of its superior aging qualities, and it is quite often spoken of as such today. Except for the difference in rubber quality and a slightly heavier fibrous covering, this wire is similar to code-grade rubber-covered wire and its outer covering is treated in the same way. It also is for general use.

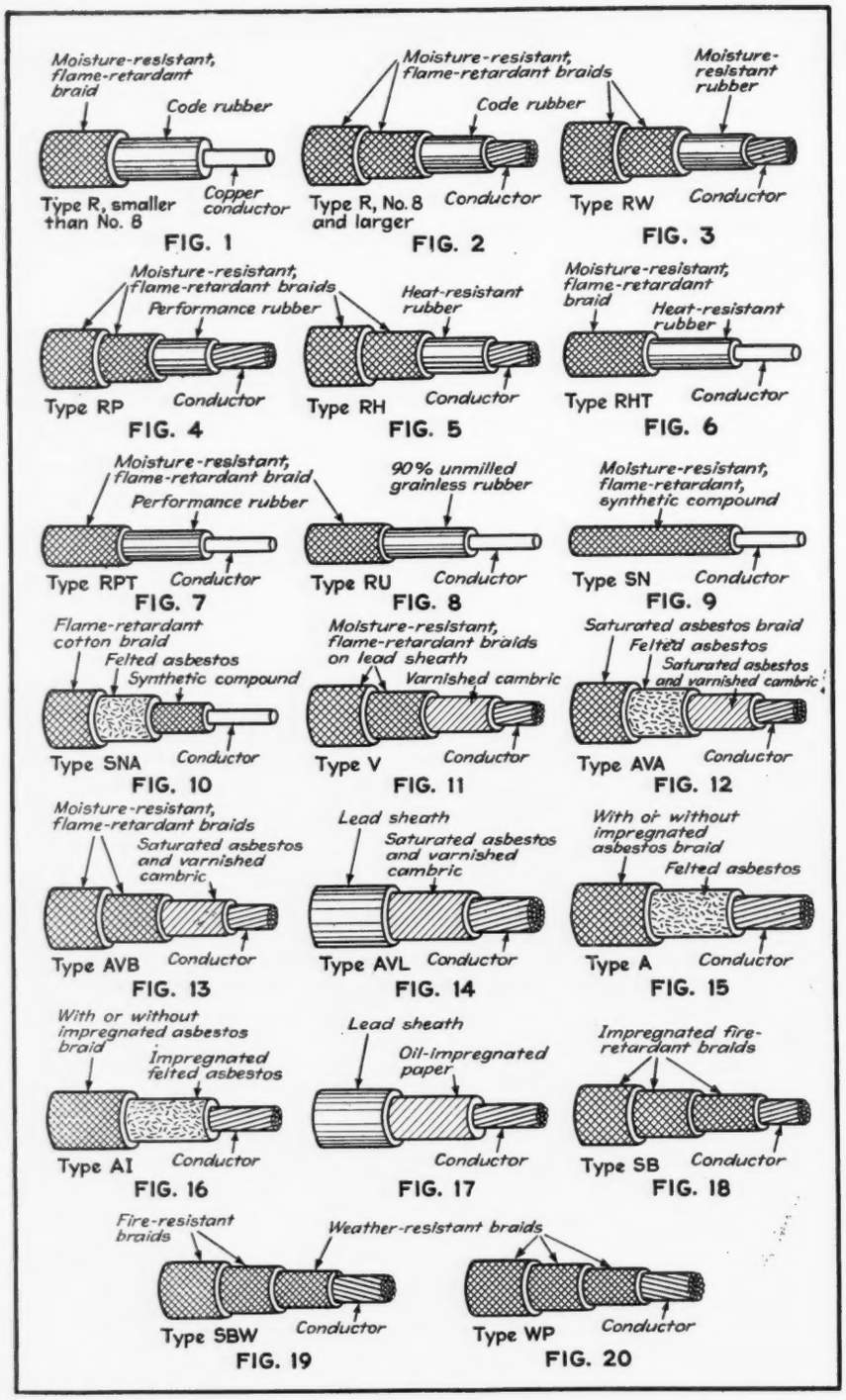
The next type of wire is exactly the same as the heat-resistant grade except that it is made in the smaller gages only, Nos 14 to 8 inclusive, has a thinner wall of insulation and requires only one braid, which results in a smaller diameter. This wire, Type RHT (Fig. 6), has the same temperature limit, 75 C (167 F) as RH wire, and is also for general use. It has been only recently produced, although the compound in the thicker wall has been in use for some years.

Small-diameter building wire of the performance grade, Type RPT (Fig. 7), is a thin-wall Type-RP material made in sizes Nos 14 to 10 and therefore requires only one braid. Otherwise, it has the same construction as RP wire and the same temperature limit of 60 C (140 F). It has only recently been produced, and is limited in application to the rewiring of existing raceways.

Thin-wall, unmilled, grainless-rubber, Type RU (Fig. 8), is made by an entirely different process from other rubber insulations and contains at least 90% rubber in its final form. Its characteristics are such that it can be made with very thin walls and yet provide the proper degree of electrical and mechanical protection. Like other rubber-covered wires, it also has a fibrous outer covering treated to be moisture resistant and flame retardant. It is made only in the small sizes, Nos 14 to 10 inclusive, and is limited at present to rewir-

TYPES OF CONDUCTOR INSULATION FOR 600 VOLTS RECOGNIZED IN 1940 EDITION OF THE NATIONAL ELECTRICAL CODE

Trade name	*Type name*	*Maximum operating temperature*	*Insulation*	*Thickness of insulation*	*Outer covering*	*Use*
Code	R	50C (122F)	Code-grade rubber	14–10 . . . . . 3/64 8–2 . . . . . 4/64 1–4/0 . . . . . 5/64 250–500 . . . . . 6/64 501–1000 . . . . . 7/64 Over 1000 . . . . . 8/64	Moisture-resistant flame-retardant fibrous covering	General use
Moisture resistant	RW	50C (122F)	Moisture-resistant rubber	Same as Type R	Moisture-resistant flame-retardant fibrous covering	General use or in wet locations. See Section 3035
Performance	RP	60C (140F)	Performance grade rubber	Same as Type R	Moisture-resistant flame-retardant fibrous covering	General use
Heat-resistant	RH	75C (167F)	Heat-resistant grade rubber	Same as Type R	Moisture-resistant flame-retardant fibrous covering	General use
Small diameter building wire (heat-resistant)	RHT	75C (167F)	Heat-resistant grade rubber	14–10 . . . . . 2/64 8 . . . . . 3/64	Moisture-resistant flame-retardant fibrous covering	General use See 3005-d
Small-diameter building wire (performance)	RPT	60C (140F)	Performance-grade rubber	14–10 . . . . . 2/64	Moisture-resistant flame-retardant fibrous covering	Rewiring existing raceways see 3005-e
Type RU wire	RU	60C (140F)	90 per cent unmilled grainless rubber	14–10 . . . . . 18 Mils	Moisture-resistant flame-retardant fibrous covering	Rewiring existing raceways see 3005-e
Solid synthetic	SN	60C (140F)	Solid flame-retardant moisture-resistant synthetic-compound	14–10 . . . . . 2/64 8 . . . . . 3/64 6–2 . . . . . 1/64 1–4/0 . . . . . 5/64	None	Rewiring existing raceways see 3005-e
Asbestos synthetic	SNA	90C (194F)	Synthetic and felted asbestos	14–8 . . . . . . Synthetic . . . 20 Mils Asbestos . . . 20 Mils	Cotton braid thickness, 20 mils	Switchboard wiring
Varnished cambric	V	85C (185F)	Varnished cambric	Same as Type R except 8 . . . . . 3/64	Fibrous covering or lead sheath	Dry locations only. Unless lead sheathed. Smaller than No. 6 by special permission.
Asbestos varnished cambric	AVA	110C (230F)	Impregnated asbestos and varnished cambric	14–8 Sol. . . . 45 Mils 6–2 Sol. . . . 65 Mils 1–4/0 Sol. . 75 Mils 14–2 Str. . . . 60 Mils 1–4/0 Str. . 80 Mils 250–1000 Str 110 Mils	Asbestos braid	General use dry locations
Asbestos varnished cambric	AVB	90C (194F)	Same as Type AVA	14–8 Sol. . . . 50 Mils 6–4/0 Sol. . 80 Mils 14–2 Str. . . . 60 Mils 1–4/0 Str. . 80 Mils 250–1000 Str 110 Mils	Flame-retardant cotton braid	General use dry locations
Asbestos varnished cambric	AVL	110C (230F)	Same as Type AVA	14–2 . . . . . 75 Mils 1–4/0 . . . . 80 Mils 250–1000 . . . 110 Mils	Lead sheath	General use wet locations
Asbestos	A	200C (392F)	Felted asbestos	14–8 . . . . . 40 Mils 6–2 . . . . . 60 Mils 1–1/0 . . . . . 90 Mils 250–1000 . . 120 Mils	With or without asbestos braid	Dry locations only. Not for general conduit installation. In raceways, only as leads to or within apparatus. If without braid or moisture resistant treatment. Limited to 300 volts.
Impregnated asbestos	AI	125C (257F)	Impregnated felted asbestos	Same as Type A	With or without impregnated asbestos braid	
Paper		85C (185F)	Paper		Lead sheath	As permitted by 2304-b, or by special permission.
Slow burning	SB	90C (194F)	3 braids, impregnated, fire-retardant thread	Same as Type V	Outer cover finished smooth and hard	For use only in dry locations where the room temperature exceeds 85C (185F)
Slow-burning weatherproof	SBW	90C (194F)	2 layers impregnated cotton thread	Same as Type V	Outer fire-retardant coating	For use only in dry locations where the room temperature exceeds 85C (185F)
Weatherproof	WP	80C (176F)	At least three cotton braids impregnated	14–12 . . . . . 3/64 10–2 . . . . . 4/64 1–4/0 . . . . . 5/64 225–500 . . . . . 6/64 525–950 . . . . . 7/64 1000 and over . . 8/64		May be used for interior wiring only by special permission.



Figs. 1 to 20—Types of electrical-conductor insulation recognized by 1940 Code

ing existing raceways, although there has been considerable experience with it for special applications. Maximum operating temperature is 60 C (140 F).

Solid-synthetic Type SN wire (Fig. 9) has a maximum operating temperature of 60 C (140 F), and differs from other wires in that it consists solely of a copper conductor and the insulating material. The insulation is a synthetic material with good insulating properties and a high degree of resistance to mechanical abuse. This latter characteristic is responsible for its recognition without an outer fibrous covering.

SN wire is non-flammable, needs no extra treatment to retard flame, and is relatively unaffected by oxygen, one of the chief deteriorating influences on rubber. In thickness the insulation is approximately the same as for the small-diameter rubber-covered wires, but its over-all diameter is slightly less than these because of the elimination of an outer fibrous covering. It is also made in larger sizes (No. 14 to 4/0) than the small-diameter rubber-covered wires.

Synthetic materials so far recognized are thermoplastic substances. At temperatures below freezing they may become brittle if handled. They are recognized not only for the rewiring of existing raceways but for special applications where rubber insulation would not be suitable.

A combination of asbestos and synthetic insulation, known as Type SNA wire (Fig. 10) is a specialty material for switchboard use rather than a building wire. Because of the asbestos-insulation combination it is recognized for a maximum operating temperature of 90 C (194 F). A treated fibrous outer covering retards flame.

Varnished-cambric insulated wire, Type V (Fig. 11), almost as well known as Type R, consists of a copper conductor, layers of varnished cambric, and a fibrous outer covering or lead sheath. This wire has long been recognized in the Code for special applications up to 75 C, which has been raised to 85 C (185 F) in view of the progress made in the varnish treatment. It is for use in dry locations only, unless lead sheathed, and generally is made in large sizes. However, sizes smaller than No. 6 are recognized by special permission of the authorities having jurisdiction.

Asbestos-Varnished-Cambric

Asbestos-varnished-cambric insulated wire, Type AVA (Fig. 12), recognized for temperatures up to 110 C (230 F), consists of a copper conductor, alternate layers of saturated asbestos and varnished cambric, and an outer asbestos braid. It is for use only in dry locations. Another type of asbestos-varnished-cambric wire, Type AVB (Fig. 13), is approximately the same as the AVA just described except for substitution of a cotton braid for the asbestos braid which results in a maximum-operating-temperature limit of 90 C (194 F). This wire is also limited to dry locations. When the combination of asbestos and varnished-cambric insulation has a lead covering, Fig. 14, it is known as Type AVL and may be used in wet locations. The temperature limitation, 110 C (230 F), is then the same as for Type AVA.

Plain asbestos-insulated wire, Type A (Fig. 15), consists of a copper conductor and felted asbestos with or without an outer asbestos braid. The asbestos has some heat-resistant but no moisture-resistant treatment. This wire has the highest permissible operating temperature of any of the wires recognized in the Code, 200 C (392 F). Its susceptibility to moisture makes it suit-

(*Continued on page* 136)

THE OPERATING ENGINEER

George Edwards
Advisory Editor

Practical Aids
Maintenance Hints
Questions — Answers

Published monthly as an integral part of POWER

Shortcuts in Combustion

Here is a handbook article explaining the meaning of flue-gas analysis and showing an easy way to figure theoretical air, actual air and actual weight of flue gas per pound of any fuel*

By PHIL SWAIN

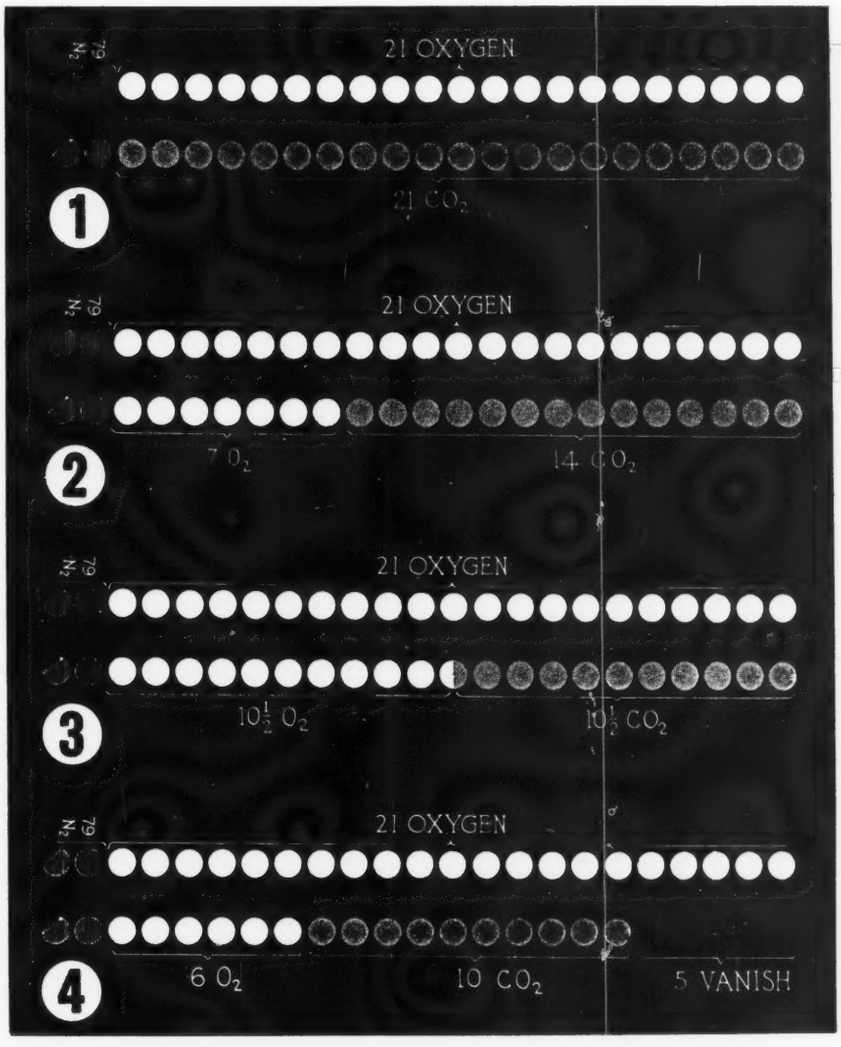


Fig. 1—Carbon burned with no excess air gives 21% CO_2 in flue gas, with 50% excess air it gives 14% CO_2 (Fig. 2) and with 100% excess air, 10½% CO_2 (Fig. 3). Fig. 4—If fuel oil is burned with 40% excess air, 100 cu ft of air will produce 6 cu ft of oxygen and 10 cu ft of CO_2, but the flue-gas analysis will be 10½% CO_2 and 6.3% oxygen

IT'S NOT MY IDEA to offer any new combustion facts or theories, but to make those already known easy to understand and use. What I have to say applies to solid fuels (carbon, coal, lignite, wood and fuel oil), but not necessarily to gas fuels.

In commercial solid and liquid fuels the only combustible elements worth talking about are carbon and hydrogen. It is true that sulphur burns, but the amount of sulphur is generally small. Whether burned in their elementary form, or the so-called "hydrocarbon" compounds, hydrogen and carbon always wind up as the same combustion products. The hydrogen always burns to water (H_2O), and the carbon burns to carbon dioxide (CO_2) ordinarily, although some of it may burn incompletely to carbon monoxide (CO) under certain conditions. For the sake of simplicity, we will assume that all carbon in the fuel is completely burned to CO_2.

So far we see that the flue gases must contain H_2O (water) and CO_2. In addition, everything else that comes into the furnace and does not fall through the grate must go up the stack —in particular all of the nitrogen in the air supplied to burn the fuel, plus all the oxygen that was not used up in burning the carbon and hydrogen.

Air "Burns"

When hydrogen or carbon combines with oxygen we usually say that the carbon or hydrogen "burns" and the

* Based on Editor Swain's recent paper before the Technical Association of the Pulp and Paper Industry.

oxygen "supports the combustion." It would be hard to defend this contention in a debate, because you could prove just as easily that the oxygen burns and the hydrogen supports the combustion.

All we really know is that the hydrogen and oxygen come together and give off heat, and which is burning and which is supporting combustion is simply a matter of somebody's "say so." Most of the time it is convenient to say that the "fuel burns," because we have to pay good money for the fuel, and that the "oxygen supports combustion," because we get an almost unlimited supply for the mere cost of transporting it.

Yet there are cases where it is more convenient to assume that the air burns and the fuel supports combustion. First, there's the matter of heat value.

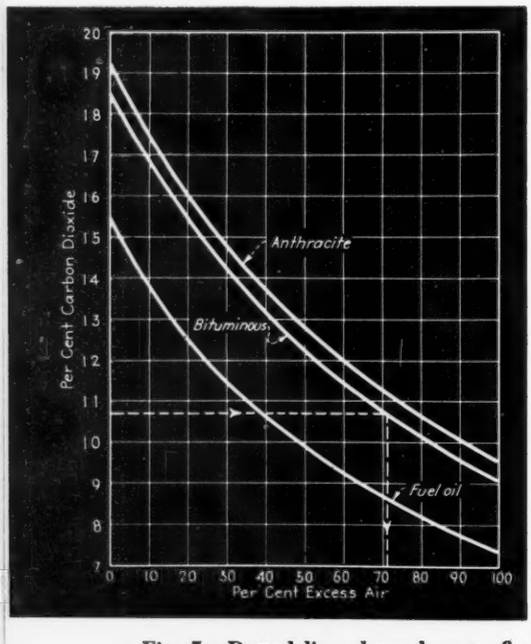


Fig. 5—Dotted line shows how to figure percentage of excess air from percentage of CO_2 in flue gas (assuming no CO). "Bituminous" curve is used also for lignite and wood

"Heat Value of Air"

If we say that oxygen is a combustible, then it must have a heat value. Moreover, air would also be a combustible and have a heat value. There is such a value, but it varies slightly according to the element with which the air burns. When air is burned with pure carbon the heat value of the air is 1270 Btu per lb. Burned with pure hydrogen, the air's heat-value is 1800 Btu per lb.

Neglecting a little sulphur, the combustible part of all coal, liquids, wood and fuel oil is nothing but carbon and hydrogen, with the carbon dominating by a wide margin. Then the heat value of air, burned with any of these fuels, would lie between 1270 and 1800, but always far closer to 1270 and closest to 1270 for fuels that are mostly carbon.

The practical value of this idea will depend upon how nearly constant the heating value of air is for a variety of fuels. It *is* constant to a surprising degree. *For all practical purposes, the heat value of air may be taken as 1310 for anthracite coal, 1350 for all other coals (including lignite and wood), and 1370 for any fuel oil.* None of these values will give an error greater than 1 or 2 percent. They are worth memorizing, because they well help solve a lot of fuel problems with practically no labor.

Air to Burn Wood

For example, suppose you want to figure how much air is theoretically required to burn one pound of any fuel. All you have to do is divide the heat value of the fuel by the heat value of a pound of air (for that fuel). For example, if a certain wood waste has a heat value of 5500 Btu per lb as fired, its theoretical air requirement is $5500 \div 1350 = 4.07$ lb of air per lb of fuel. In figuring the usual way you'd have to start with the ultimate analysis of the fuel and fill half a page with arithmetic and chemistry. Here you get the answer with one division.

If this wood is burned with 50% excess air, the actual air supplied per pound of wood burned will be $4.07 \times 1.5 = 6.1$ lb. Now, what goes up the stack? The answer is "all the wood, plus all the air supplied to the furnace, minus any ash that goes through the grate." Since the ash doesn't usually amount to much, the weight of flue gas equals weight of fuel plus weight of air, in this case $6.1 + 1 = 7.1$ lb of flue gas per pound of wood.

Note the simplicity of this method. Note also that it is accurate enough for most practical needs of operating engineers.

I have shown how the idea that air burns, and has a heat value, leads directly to a shortcut method of figuring how much air it takes to burn one pound of any fuel. The same idea has another application. It helps you understand the meaning of flue-gas analysis.

How Air Burns to Flue Gas

In the following discussion I am going to deal with gas volumes, not weights, because both air and flue-gas analyses are normally reported on a volume basis. Also, to make sure the air and flue-gas volumes are on the same basis, I shall assume that the flue gas is cooled to room temperature before we measure its volume.

To get the following picture right, *imagine that you are burning air into flue gas,* using a so-called fuel as a supporter of combustion. The nitrogen in the air doesn't burn, so the volume of nitrogen in the flue gas must equal the volume in the air. The same is true of any oxygen that doesn't burn (that is, any *excess* oxygen). On the other hand, any oxygen that combines with carbon produces an equal volume of CO_2.

Any oxygen that burns with hydrogen produces a greater volume of water vapor, but this condenses to liquid water before analysis, so the hydrogen simply "vanishes," as far as the flue-gas analysis is concerned.

We can better see what happens if we represent 100 cu ft of air by 100 poker chips, of which 79 dark chips represent nitrogen and the 21 white chips represent the 21 cu ft of oxygen. In Fig. 1 this is burned with exactly the right amount of carbon to use up the oxygen. Then the 21 volumes of oxygen produce 21 volumes of CO_2, and we have flue gas containing 21 cu ft of CO_2 and 79 cu ft of nitrogen. In this case flue gas must analyze 21% CO_2.

Fig. 2 shows what happens when pure carbon burns with 50% excess air. Fourteen volumes of oxygen "burn" and seven don't burn, the seven being 50% of the 14. When the air burns, in this case, the 79 cu ft of nitrogen and the 7 cu ft of unburned oxygen go through unchanged. The 14 cu ft of oxygen produce 14 cu ft of CO_2. The flue-gas analysis is, therefore, 79% nitrogen, 7% oxygen, and 14% CO_2.

Fig. 3 illustrates the case of 100% excess air. Here 10½ cu ft of oxygen burn to CO_2, and an equal amount goes through unchanged. The resulting flue-gas analysis is 79% hydrogen, 10½% oxygen, 10½% CO_2.

From the demonstration you can draw an interesting conclusion. If the fuel contains no hydrogen, you can figure the excess air from the flue-gas analysis by simply dividing the percentage of oxygen by the percentage of CO_2 and multiplying by 100. For example, in Fig. 2, the excess air $(7 \div 14) \times 100 = 50\%$. This rule applies *approximately* to low-hydrogen fuels, such as anthracite coal and coke. Don't attempt to apply it to high-volatile bituminous coal or oil.

Effect of Hydrogen

This simple rule will be in serious error with fuels containing much available hydrogen (particularly fuel oil). This hydrogen will combine with oxygen to produce water which will dis-

appear in the analysis, so that 100 cu ft of air will produce less than 100 cu ft of flue gas.

This is illustrated by Fig. 4, representing the burning of fuel oil with 40% excess air. Here 15 cu ft of oxygen burn and 6 do not, and $(6 \div 15) \times 100 = 40\%$. When oxygen burns with fuel oil, about two-thirds of the oxygen consumed combines with carbon to form carbon dioxide; the other third combines with hydrogen to form water, which vanishes. Therefore, if 15 cu ft of oxygen burn with the fuel oil, 10 will burn to CO_2 and 5 will vanish. In the case illustrated, then, the flue gas will contain 79 cu ft of nitrogen, 6 cu ft of oxygen, and 10 cu ft of CO_2. These, however, are not percentages because they don't add up to 100. Thus:

	Cu Ft	*Percent*
Carbon dioxide	10.0	10.5
Oxygen.....	6.0	6.3
Nitrogen	79.0	83.2
Total	95.0	100.0

The three curves shown in Fig. 5 will take care of fuels that contain hydrogen as well as carbon. They will give you the percentage of excess air for any percentage of CO_2 in the flue gas. Note that the curve marked "bituminous" can also be used, with reasonable accuracy, for lignite and wood. Thus, if the flue gas from a wood fire contains 10.7% carbon dioxide, the excess air is 71%.

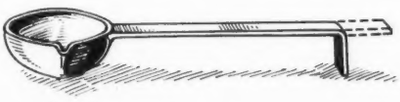
As already shown, the theoretical air needed to burn one pound of wood can be figured by dividing the heat value by 1350 Btu. To this theoretical air add 71 percent to get the actual air. To this add 1 lb to get the actual weight of flue gas per pound of wood fired.

To sum up, you can solve practical flue-gas problems if you have the chart shown in Fig. 5, remembering that the heating value of air is 1310 for anthracite, 1350 for bituminous coal, lignite and wood, and 1370 for fuel oil.

✦ ✦ ✦

Add Safety to Babbitt Ladle

OUR BABBITT LADLE HAD A LONG STRAIGHT HANDLE, so that if we wanted to set it down in a horizontal position it was necessary to put a block under



the end of it. To simplify this problem we turned the end of the handle back under, as in the figure. Since the ladle is now easy to set down, workmen are more likely to handle it safely and not take unnecessary chances.

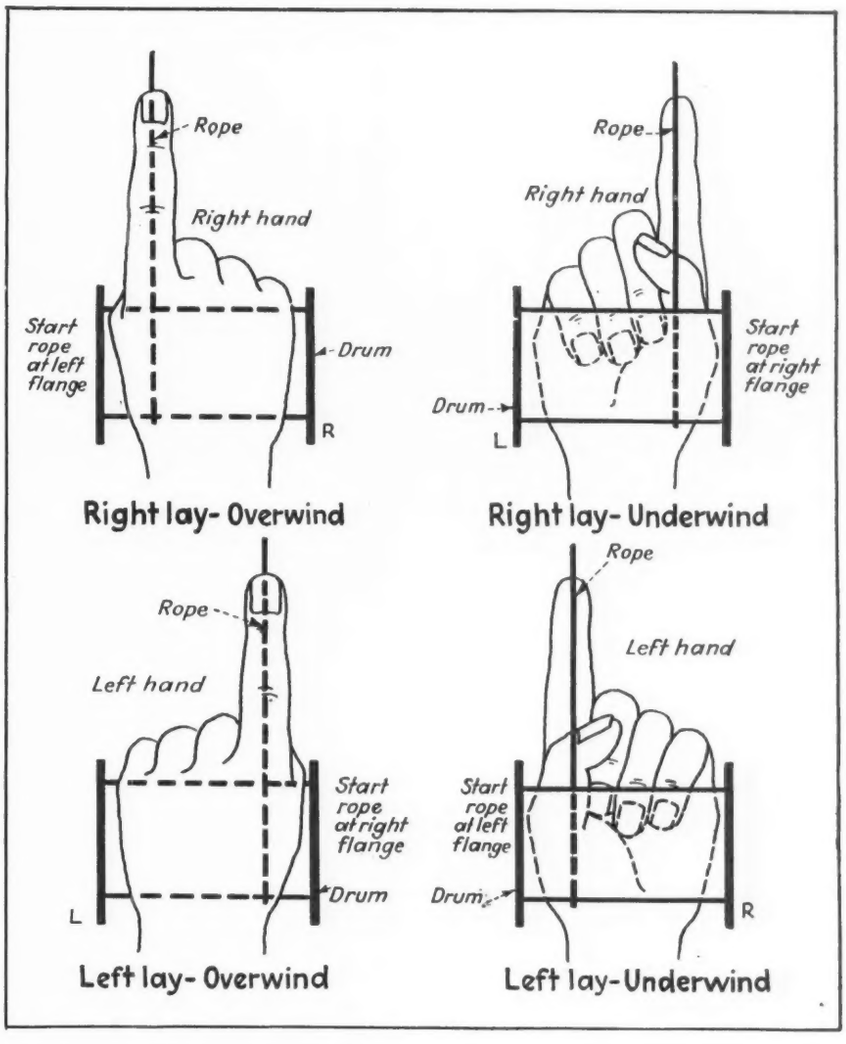
St. Louis, Mo. O C MILES

Hand Rule Simplifies Rope Reeving on Drum

THERE IS A RULE, a rather complicated one, that tells at which drum-flange to start roping a smooth drum. If started at the proper flange the rope will wind with the wraps tightly hugging each other, and there will be no space between wraps into which a wrap from the layer above might squeeze and cause serious scrubbing, scarfing or binding.

When a right-lay rope is being underwound on the drum (which is to say, it leads from the bottom of the drum) start it from the right flange, looking at the drum from the rear. If a left-lay rope, start it from the left flange. Conversely, if a right-lay rope is being overwound (that is, it leads from the top of the drum) start it from the left flange. If a left-lay rope (overwound) start from the right flange.

That's a complicated rule to remember, and more frequently than not quick reference to it is not available at the machine. So here's a far simpler rule. Using your doubled-up fist to represent the drum, and the index finger to indicate the flange. With right-lay rope use the right fist, with left-lay rope the left fist. For overwound rope keep your fist back up, for underwound rope palm up. Pointed to the drum the index finger will indicate both how the rope should lead from the drum and from which flange. The diagrams show how easily this rule may be applied.



Wilkes-Barre, Pa. ERNEST WELLHOFER
Chief Engineer, American Cable Div

It Takes More Steam to Heat Small Hotels

Existing data for hotel-heating requirements take no account of the relatively larger exposed surface of smaller hotels. Higher steam use is to be expected, reports Otto E Stossel

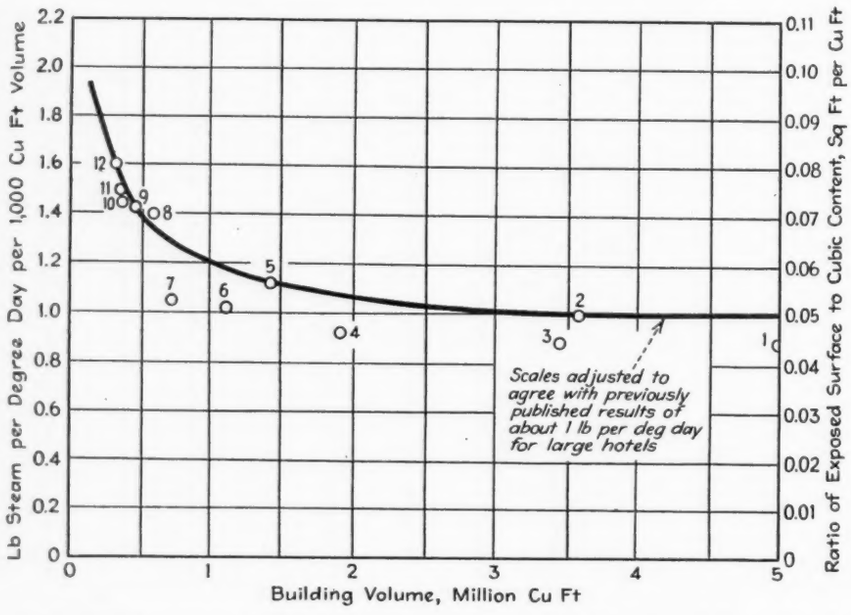

Lb Steam per Degree Day per 1,000 Cu Ft Volume
Ratio of Exposed Surface to Cubic Content, Sq Ft per Cu Ft
Building Volume, Million Cu Ft
Scales adjusted to agree with previously published results of about 1 lb per deg day for large hotels

Fig. 1—Heating steam in lb per deg day follows closely the curve of the ratio of calculated exposed surface to volume of usual hotel construction

CHECKING HEATING COSTS for a number of hotels against previously published figures has given very satisfactory comparisons for buildings with a cubic content over 2,000,000 cu ft. When applied to smaller buildings, however, actual steam consumptions appear to be all out of line with the averages reported by Earle Shultz and J C Butler (POWER, August, 1940) of 0.99 lb per degree day per 1000 cu ft and the previous figure of 0.97 lb published by Professor Charles Sayles (POWER, November, 1937).

Granting the possibility that some plants may be using an excessive amount of steam, others are known to be in good condition and efficiently operated. Figures in the table cover 12 hotels ranging from 250,000 to 5,000,000 cu ft with heating steam figures taken over a 7-months period. As most of these plants do not have reliable metering equipment, steam for heating was determined by subtracting average summer fuel consumption from corresponding winter figures. Boiler efficiencies were estimated very conservatively, 55% for hrt boilers, for example.

Although the inaccuracy of this method is fully realized, it cannot account for the discrepancies noted. Furthermore, where calculated values could be checked with metered consumption, close agreement was found.

From the table, a rapid rise of steam consumption per 1000 cu ft per deg day is apparent as the building content decreases below 1,500,000 cu ft. The very nature of most hotel structures allows expansion of only two directions, length and height. The width, within limits, must stay approximately the same because it is limited by the hall and a room on each side.

Width of hall and rooms has no relation to size, but varies with the type of hotel from about 40 to 75 ft. Any of the various shapes of building wings can be considered laid out in a straight line. The ratio of exposed surface to volume of a building 50 ft wide is a curve rising rapidly with decreased building size.

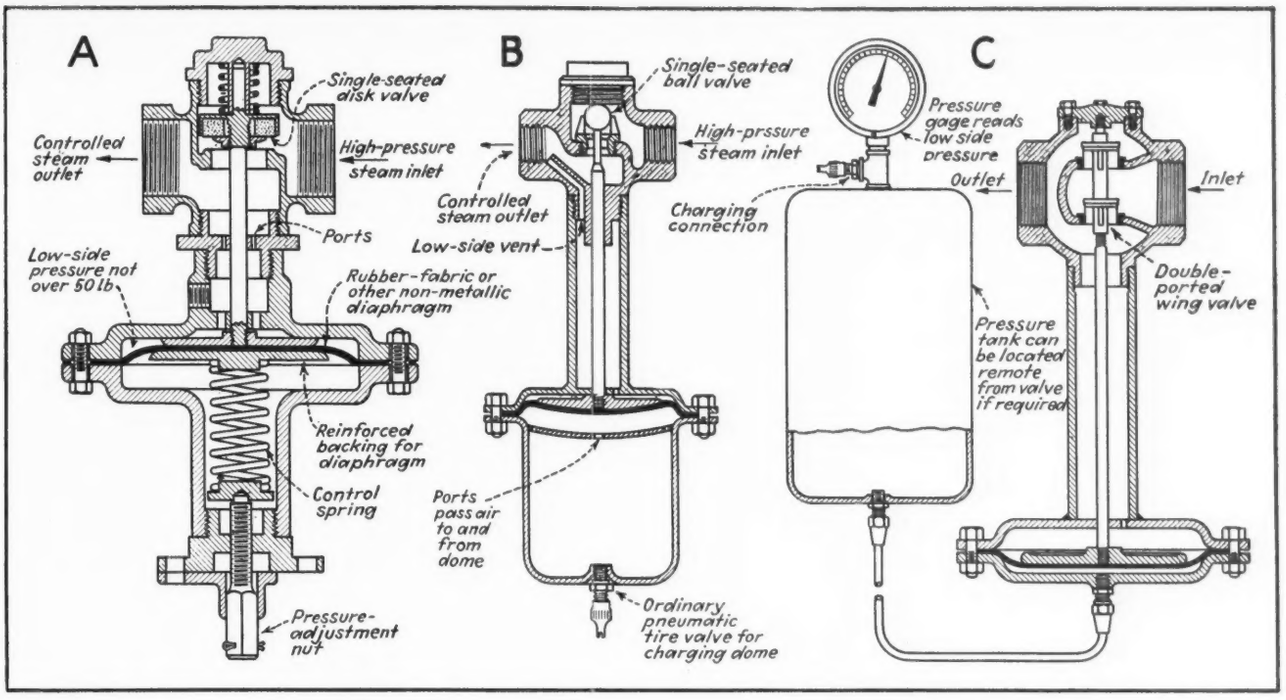
For comparison, the exposed surface to volume ratio is plotted in Fig. 1, for a building 50 ft wide with height and length increasing proportionately. Heating steam figures for 12 hotels are entered with scales appropriately selected to bring the larger hotels into line with about 1 lb per deg day per 1000 cu ft.

One must understand that innumerable factors influencing steam consumption have been neglected in this comparison, as was the case for the previously published figures. Each plant is subject to these individual corrections and it is to be expected that the plotted points will lie considerably away from any average curve.

From these results, it appears that hotels with a cubage under 1,500,000 will require a correction factor for size if an average figure is being used for comparison or calculation. This difference will be more pronounced in buildings under 500,000 cu ft, or in high, narrow ones.

TABLE I

Chart point number	*Cubic content of hotel, cu ft*	*Heating steam, lb per deg day per 1,000 cu ft*
1	5,000,000	0.87
2	3,580,000	1.00
3	3,450,000	0.87
4	1,914,000	0.93
5	1,416,000	1.12
6	1,100,000	1.02
7	720,000	1.05
8	583,000	1.40
9	465,000	1.42
10	352,000	1.46
11	349,000	1.50
12	295,000	1.60



***A*—Spring-loaded reducing valve in open position. As spring compresses due to smaller flow, downstream pressure rises. *B*—Dome valve has air pressure in closed chamber acting on lower side of diaphragm to balance steam pressure. *C*—Larger volume of connected tank, less affected by movement of diaphragm, gives better regulation. Three types of valve illustrated—single-seated disk, single-seated ball or double-ported construction—can be used with any regulator**

Air-Loaded Valves for Steadier Pressures

Air pressure in a dome or tank instead of a steel spring can hold more uniform downstream pressure, says E T McCarthy, regulating-valve designer for Klipfel Mfg Co

USE OF "AIR SPRINGS" instead of steel ones for controlling pressure-regulating valves dates back at least to 1886 when a couple of chaps named Sauer and Sievern used the idea in a patented gas-pressure regulator. Pilot-controlled valves using compressed air as the operating medium are well known but they require a continuous supply of pressure air. Spring-loaded direct-acting valves are sturdy and dependable but allow considerable variation in service pressure as the valve port changes from nearly closed to wide-open position.

Direct-acting valves in which the low-side service pressure is balanced by air under pressure in a tank or dome should not be confused with pilot-controlled valves that require a continuous supply of compressed air. In the former, the air dome can be charged with compressed air from a "bottle" or hand pump. It will then hold its charge indefinitely.

To hold a nearly constant pressure as flow changes through a reducing valve, the valve stem must move to open or close the disk with respect to the seat. In a spring-loaded valve, the difference in length of the spring due to this motion causes a greater force on the diaphragm when the valve port is nearly closed, and produces a 10% or more increase in service pressure. The unbalanced pressure on the diaphragm requires it to be strong enough to stand working pressure. Its variation in area may add another 10% to the variation in downstream gage reading.

A dome valve, on the other hand, can have a thinner diaphragm, since the air and steam pressures are balanced and act over the entire surface of both sides equally. This gives practically zero variation (change in downstream pressure) due to the diaphragm itself.

As for the effect of valve-stem travel, a dome valve having about $\frac{1}{4}$-in. motion and a 6x7-in. cylindrical dome will have only about $2\frac{1}{2}\%$ change in absolute pressure under the diaphragm regardless of working pressure. This percent change depends on the volume of the dome and can be decreased to any value desired by using a bigger dome or separate air tank.

Adjusting an air-loaded valve to hold higher or lower service pressure requires only adding to or bleeding off air to the dome through the charging connection. In operation, however, service pressure will vary if air temperature in the dome or tank changes.

This variation is, fortunately, proportional to the change in *absolute* temperature of the air. A 10-deg change from 70 to 80 F, for example, will affect the service pressure by about 2%. If the dome is subject to more than usual temperature change, a separate tank is recommended for location in a place where conditions are reasonably stable.

PRACTICAL AIDS TO OPERATION

Capacitors Save $6900 In One Year's Operation

POWER FOR A SOUTHERN ORE REFINERY is purchased at 2200 volts from the local utility and stepped down at the plant to 440 volts. Power charges are based on a monthly kva demand, plus an energy rate. Energy in excess of 250 kwhr per kva of billed demand was obtained at a rate of 1.5 mills less than the standard energy rate. The company engineers, realizing that raising the plant power factor would increase the number of kilowatt-hours obtainable at the lower energy rate and at the same time reduce the kva demand, decided to install capacitors.

At the end of the first year's operation a group of sixty 15-kva capacitors sliced $6900 from the power bill by raising the power factor from 78 to 92%. The reduction in power costs was sufficient to pay the capacitor costs in 14 months. Load is chiefly squirrel-cage induction motors, usually operated at less than 66% full load, which resulted in an over-all power factor of 78% for the entire plant before the capacitors were installed.

Each feeder supplying a low-power-factor load has a 15-kva, 460-volt capacitor on its substation end. Capacitors are mounted atop the metal-clad switchgear, each unit above a corresponding feeder circuit-breaker panel. This location worked out best due to the load condition on the feeders. The capacitors are in the circuits continuously, being switched out only at infrequent intervals for inspection.

East Pittsburgh, Pa. R E MAUBURY
Westinghouse Elec & Mfg Co

Commutator Connections Caused Sparking

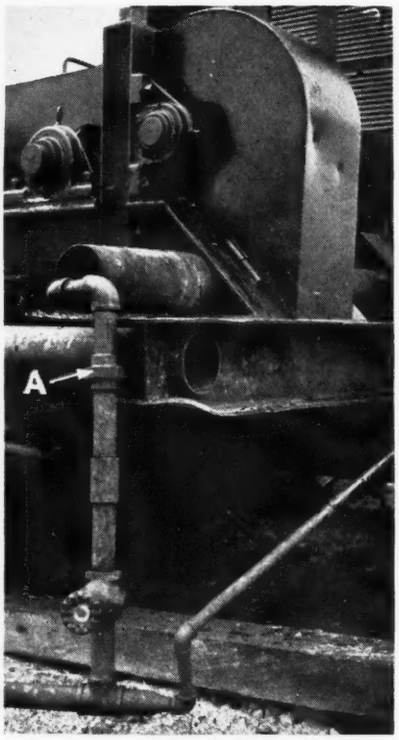
A DIRECT-CURRENT GENERATOR started to spark at the commutator and brushes after a year's service. All the usual cures for this trouble were tried without stopping the sparking. Then we unsoldered some of the coil leads from the commutator bars and were surprised to find them oxidized and black. This showed that originally the leads had not been properly soldered to the commutator.

We disconnected completely the winding from the commutator, cleaned the ends of all leads and slots in the commutator bars to bright copper. The leads were then put back into place and carefully soldered. When the machine was put back into service it gave no further trouble from sparking.

Plainfield, N. J. H W HODGSON

Warmed Butane Line Saves Fuel Costs

PLANTS USING BUTANE GAS for stationary engines outside of the building usually find that fuel consumption increases sharply during the colder winter months due to the richer, less volatile mixture delivered to the carburetors. One plant engineer effected



a worthwhile saving in fuel costs by running the fuel lines leading to the engines through 12-foot sections of 8-in. exhaust line. A quicker warming-up period, greater power flexibility, and less trouble in carburetor adjustments were immediately noticed, along with the lower fuel consumption.

As this particular installation was

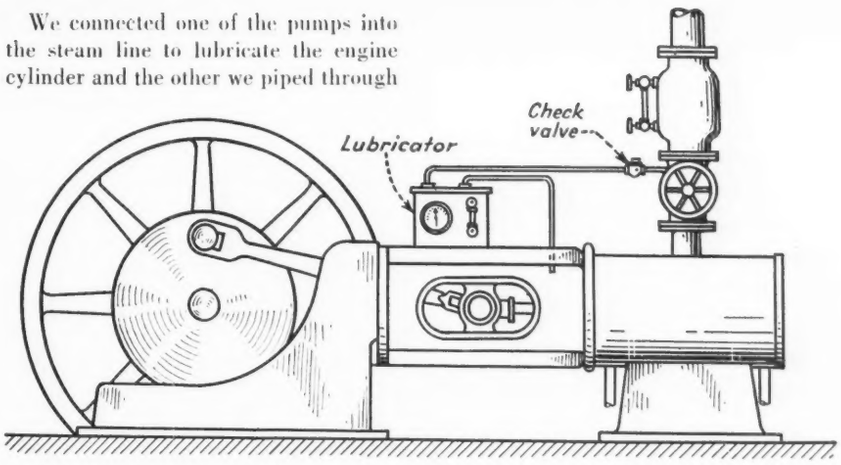
portable, provision was made for easy moving by leaving a union in the fuel line at *A* just outside of the exhaust pipe. The outside line can be disconnected easily, leaving the fuel pipe permanently within the exhaust line.

Pomona, Calif. GILBERT M WILSON

Lubrication Cures Packing Troubles

WE HAD TROUBLE WITH THE PISTON AND PACKING on a small steam engine because the rod was not properly lubricated. The rod was given a swab of oil when the watch engineer happened to think of it. As a result it either had a feast or a famine of lubricant. The old lubricator on the engine failed so we installed a new one with two pumps.

We connected one of the pumps into the steam line to lubricate the engine cylinder and the other we piped through

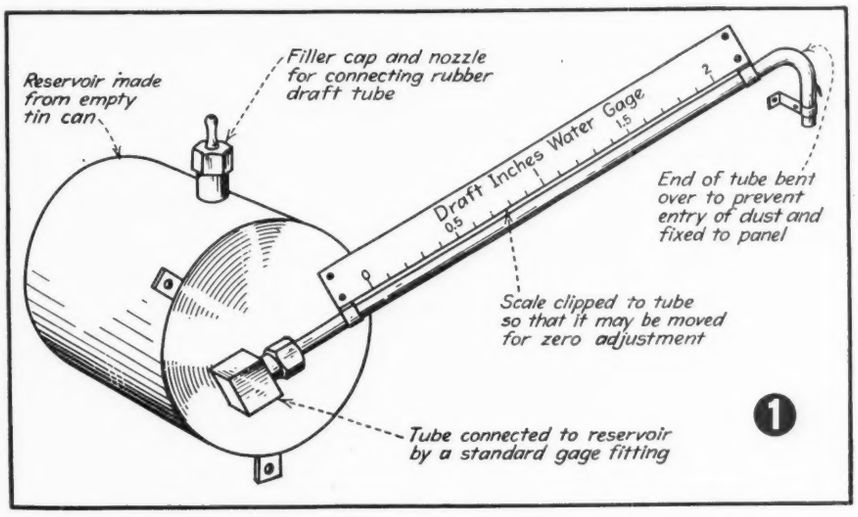


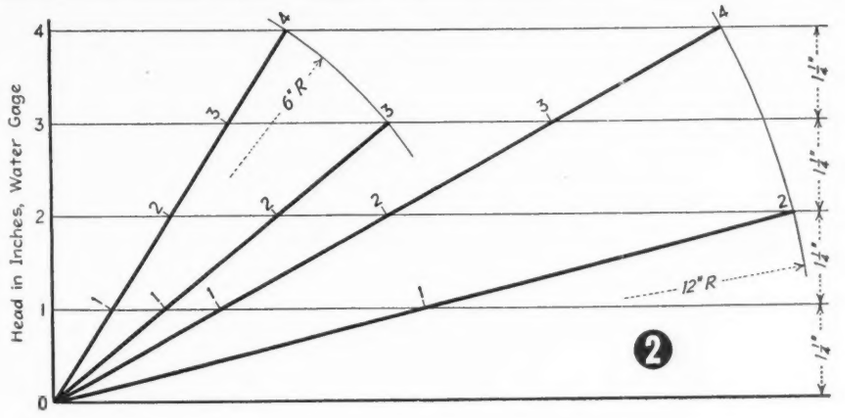
a hole in the engine frame directly over the piston rod and about 3 in. away from the packing gland, as in the figure. Now we feed just enough oil to the rod to keep it cool and the packing lasts for a full year. The saving paid for the lubricator in less than two years.

Englewood, N. J. R BOETTINGER

Tin Cans, Glass Tubes Make Draft Gages

WE NEEDED SEVERAL DRAFT GAGES in our work, but could not get them. We could, however, get ⅜-in. outside diameter glass tube so proceeded to build the gages. For the gage reservoirs we used tin cans, 6-in. in diameter nd 4 in. long, with the covers soldered tightly in place. We soldered a ⅜-in. gage-glass fitting to one end of each can, as in Fig. 1. At the approximate top of the can when installed we cut a hole and soldered a fitting for a filler cap and nozzle. Lugs were also soldered to the can for panel mounting.


Reservoir made from empty tin can
Filler cap and nozzle for connecting rubber draft tube
Draft Inches Water Gage
End of tube bent over to prevent entry of dust and fixed to panel
Scale clipped to tube so that it may be moved for zero adjustment
Tube connected to reservoir by a standard gage fitting
1



For gage fluid we used kerosene, which is about 0.8 as heavy as water. Therefore, a gage pressure of 1 in. of water equals 1 ÷ 0.8 = 1.25 in. of kerosene and we laid out our gage scales accordingly, see Fig. 2. The maximum scale range required for our work would not exceed 4 in. of water so that we laid out the vertical scale "Head in Inches, Water Gage," 1¼ in. between each division.

From each of these divisions we drew horizontal lines. As our gages were made with 12-in. scales, with 0 as a center and the compasses set for 12 in., we drew an arc through the horizontal lines as shown. Lines drawn from the intersections at 2 and 4 on the 12-in. radius to 0 gave us the correct inclination of the tubes for a maximum of 2 and 4 in. of water-gage readings. The divisions between the intersections of the inclined and horizontal lines were each divided into 10 equal parts to give 0.1 in. or even finer scale readings if desired.

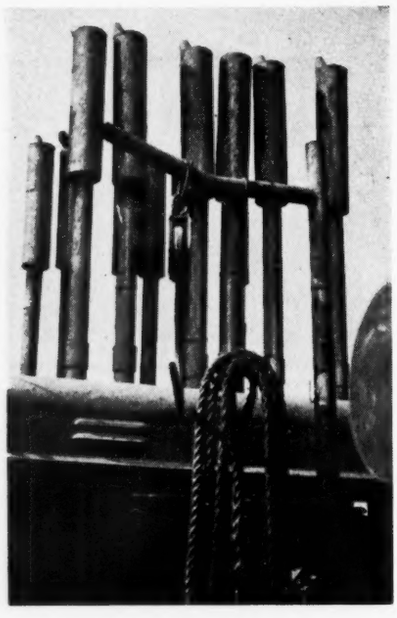
From the chart, Fig. 2, we laid off the scale for our gages. After the scales were made, fittings were attached to them so that they could be clipped to tubes and easily moved to zero adjustment. When mounting the gage we took care to get the tube at the correct angle and sealed its lower end into the fitting with iron cement. To make it easy to read the gage we painted back of the tube white.

When filling the reservoir, care was taken to get out all air bubbles. This

was done by a few gentle sucks and blows on the end of the tube. When the reservoir was filled to place the zero at the desired level, zero on the scale was moved to this point. For readings below atmosphere the connection was made to the open end of the tube, which we turned down to keep dirt out. For pressures above atmosphere the connections were made to the nozzle on the filling cap.

There is an error in the gage due to change in liquid level in the reservoir; but when the reservoir is made large this error may be neglected. We have several of these gages in use with satisfactory results.

T D OSWALD
Newcastle on Tyne, England

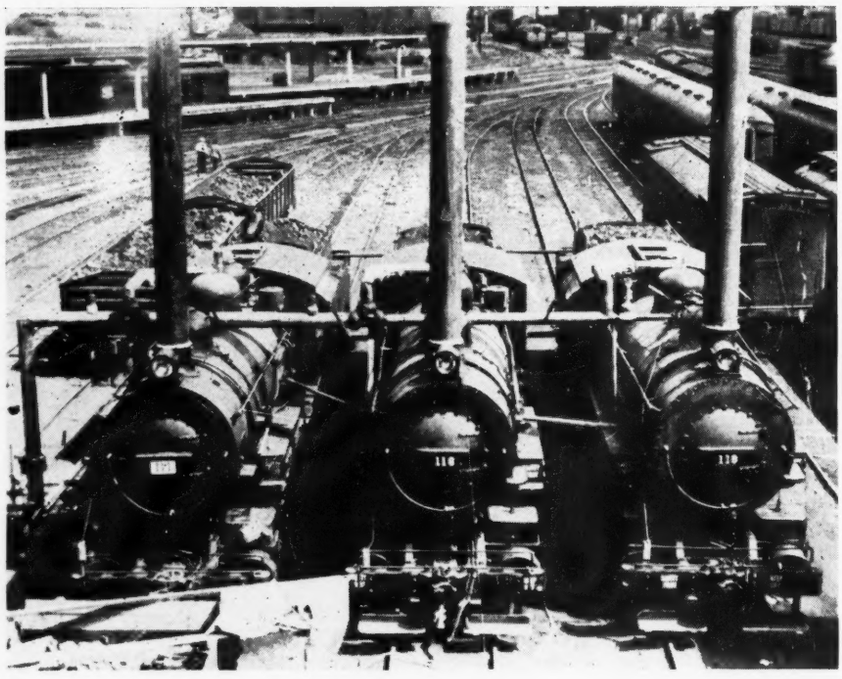


Multiple Muffler Reduces Engine Exhaust Noise

IN CONGESTED BUSINESS and residential districts noise caused by internal-combustion-engine exhaust is always objectionable. One contractor solved this problem by installing a separate muffler on the exhaust of each cylinder of his engines, as in the photo. The mufflers, of simple automotive type, have a slightly higher initial cost than a single large muffler for all cylinders, but this is more than well spent because of the reduction in noise.

Risers of 3-in. pipe run vertically from each exhaust port. Exhaust openings on the mufflers are turned in different directions to divert the noise as much as possible from any one area. As the combined area of the small mufflers is greater than for a single muffler they operate cooler and have a longer life than a single large unit. It was also found that the engines operated cooler with the multiple muffler system. Even though this system was used on large portable engines, it has possibilities on stationary engines where exhaust noises must be reduced to a minimum.

Pomona, Calif. GILBERT M WILSON



Locomotives Supply Temporary Steam Load

LAST FALL engineers of the Terminal Railroad Association, St. Louis, found that the large stack at the 18th St Station needed relining. To do this, it was necessary to shut down the plant and find another steam source while the job was being done. This problem was solved by using three locomotives, as in the photo. Very little information was available on the efficiency of locomotives used in this manner, so to provide complete data, a water flowmeter, steam flow meter, draft gages, temperature instruments and orsats were installed.

It required 12 days to reline the stack, and the locomotives furnished the necessary steam without any trouble, operating at an over-all average efficiency of 74%. Peak demand was 35,000 lb of steam per hour at 155 lb per sq in. From orsat tests made at 15-min. intervals, an average of 10.2% CO_2 was obtained.

The installation and operation of this plant was supervised by Frank Ross, superintendent of motive power and equipment, and Walter Steinheimer, chief engineer of power plants for the Terminal Railroad Association.

Philadelphia, Pa. S D DISTELHORST
Cochrane Corp

Separate Conduits Overheat Insulation

ALL CONDUCTORS OF AN AC CIRCUIT must be in the same conduit if you want to keep out of trouble, as the following example will show. A 3-phase generator installed by the purchaser refused to take full load when paralled with other machines. A trouble man sent in to investigate discovered by odor that insulation was overheating somewhere. When he got down into the pit under the generator to check the connections, he found that each of the three leads from the generator had been run in a separate conduit to the oil switch on the switchboard.

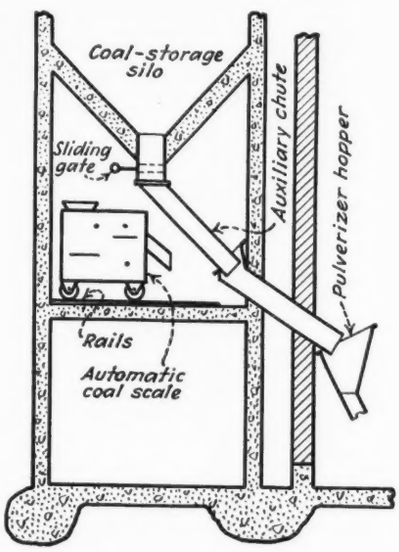
This condition produced two troublesome effects. First, the alternating magnetic field around each conductor induced heavy eddy currents in the conduit that increased its temperature beyond the safe limit of the cable insulation. Second, the iron conduit also increased the inductance of each cable to where the counter-voltage in-

duced in it prevented the generator picking up its share of the load. When the three cables were installed in the same conduit the generator operated satisfactorily.

Trenton, N. J. R O CUMMINGS

Auxiliary Chute Keeps Pulverizer in Service

IN OUR PULVERIZED-FUEL-FIRED BOILER PLANT coal is fed to the pulverizers from storage silos equipped with automatic motor-driven scales that weigh the coal to the pulverizer hoppers. There was always the possibility of something making the scales inoperative, so we decided to provide an

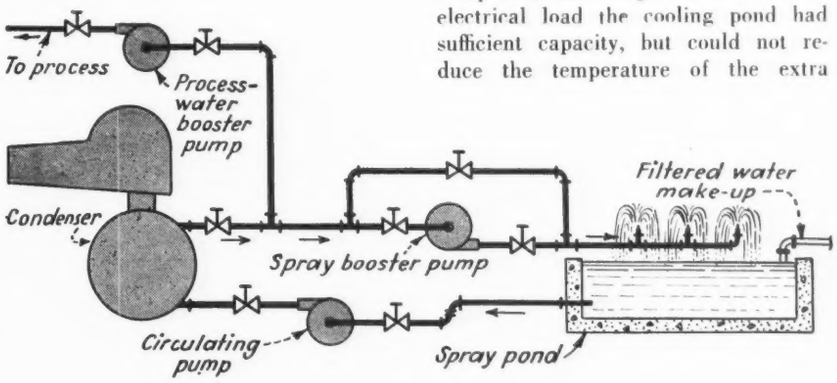


auxiliary means of getting coal from the silo to the pulverizer hoppers.

This was done by mounting the scales on flanged wheels to run on rails so they could be run back out of the way, as in the drawing. A special chute, easily attached to the silo outlet and long enough to reach the pulverizer hoppers, is kept in the scale room where it is readily available. Scale motors are connected by flexible cords and attachment plugs to the power source. If a scale fails to operate now, it is only a matter of a few minutes to disconnect it, push it back out of the way and connect the temporary chute.

Each pulverizer hopper and feeder chute contain coal enough for about 10 min. operation after the scale stops. This is sufficient time to make the changeover to the auxiliary chute. To warn the operators that a scale has stopped, we installed a switch on each chute from the scale to the pulverizer hopper. This switch is held open by a paddle-like device as long as coal is in the chute. When the chute is free of coal the paddle drops, closes the switch, and sounds an alarm.

Lynchburgh, Va. O M ROBERTS



Booster Pump Increases Spray-Pond Capacity

AT A LARGE MANUFACTURING PLANT an increase in electric-power generation created an excess of exhaust steam that upset the heat balance of the power plant. This problem was somewhat complicated because it was necessary to maintain a vacuum in the condenser that would give a circulating-water temperature of around 105 F. Part of this water was used in process and part went to a spray cooling pond. In the cooling pond the water mixed with filtered water and returned to the condenser.

Up until the large increase in the electrical load the cooling pond had sufficient capacity, but could not reduce the temperature of the extra water from the condenser enough. Various schemes for increasing the capacity of the cooling pond were considered, but a booster pump, connected as in the figure, was selected as the simplest and least expensive. The pump increased the pressure on the spray nozzles and consequently the height of the sprays. This arrangement brought the condensing-water temperature to normal and increased plant efficiency.

Roanoke, Va. S H COLEMAN

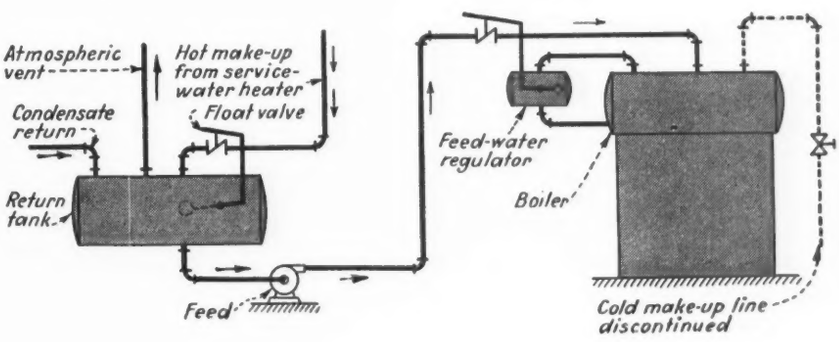
Hot Makeup Water Reduces Corrosion

CORROSION OF THE CONDENSATE-RETURN LINES was so severe in our heating system that sections of pipe had to be replaced at 3-year intervals. A search for the cause and a remedy revealed that the condensate had a low pH, or an acid characteristic. Raw makeup water was fed to the boiler under hand control. Percentage of makeup was high, because large quantities of steam were used directly in process. We decided that the impurities in the water, largely in the form of dissolved gases released under the influence of heat, were responsible for the trouble.

To get rid of these impurities as much as possible, with the existing equipment, all boiler feedwater is now taken through a service-water heater. From the heater the makeup water flows into the condensate-return tank under float-valve control, as in the diagram.

As the temperature of the water in the receiver is around 205 F the dissolved gases are released and vented to atmosphere. A newly installed feedwater regulator insures water flow to the boiler in proportion to steam demands. Following these changes, corrosion of the condensate-return lines has been greatly reduced, as proven by decreased pipe replacements.

Richmond, Va. C R ANDERSON



READERS' PROBLEMS

Questions from Our Readers

How to Improve Operation Parallel Pump

Question 1

WE HAVE TWO *duplex packed-piston pumps feeding, under peak load conditions, three boilers. Boilers are equipped with feedwater regulators and the pumps have the usual governors. At a given load, these pumps act all right but as the load changes, one or the other has a tendency to pick up most of the load while the remaining unit makes short fast strokes. What causes this condition and how can we improve parallel operation of these pumps?* —RFD

Purging Ammonia System

Question 2

FOR PURGING *our ammonia system of air, we have a hose connected to the top of an oil trap and into a barrel containing about 30 gal of water. When purging we just crack the purge valve. The water rumbles as when steam is discharged from a hose into water. There is little noise or odor until a fog appears and then there is a cracking sound. Is this method correct? Can* POWER *readers suggest a better method?* JAC

Diesel Generators as Synchronous Condensers?

Answers to May Question 1

The Question

I AM ABOUT TO ASSUME *charge of a power plant where we contemplate installing diesel-engine generating units for peak load. At off times we wish to use the diesel generators for synchronous condensers. Perhaps* POWER *readers can offer some suggestions as to the advisability of this arrangement and the method of hookup.*—RFN

Must Free Generator of Engine Drag

DIESEL-ENGINE GENERATORS can be used as synchronous condensers, for power-factor correction, if care is taken to insure that they are freed of engine load or "drag." If RFN installs clutches that can be released, this would be an ideal solution. Otherwise the coupling bolts must be removed, which is impossible unless the generators have two bearings. Another procedure involves disconnecting the connecting rods and blocking the pistons up out of the way, allowing the shaft to turn with the generator. Of course, if the engines happen to be belted to the generators, the belts can be removed. In any event, the important thing is to free the generator of engine drag.

Starting the generators is a problem. If RFN's plant is connected with an outside power source, they may not allow him to start on the line. The starting currents will be high. If the engines can be arranged to bring the generators up to speed and then disconnect, as with a clutch, this makes a perfect setup. I think RFN will find the advantages of this latter scheme far outweigh the disadvantages of higher cost. If RFN has a spare generator, he might use it for starting purposes.

Carlsbad, N. M. E A ROBERTS

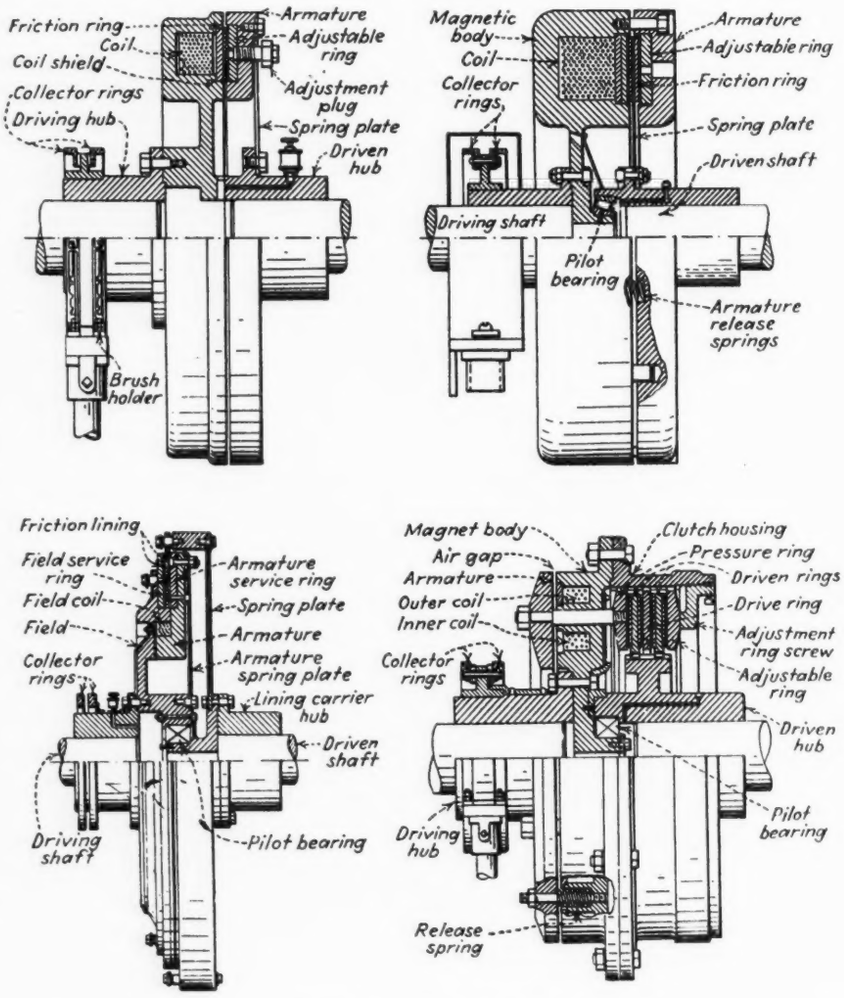
Experience Indicates Idea is OK

I HAVE INSTALLED several plants in which diesel engines have been connected to their respective alternators through clutch couplings, thus allowing the alternators to float on the line as synchronous condensers when not operating as generators. The results were just as anticipated; power factor was greatly improved, and voltage regulation was much better. Such an arrangement simplifies automatic control of the diesel units, if desired.

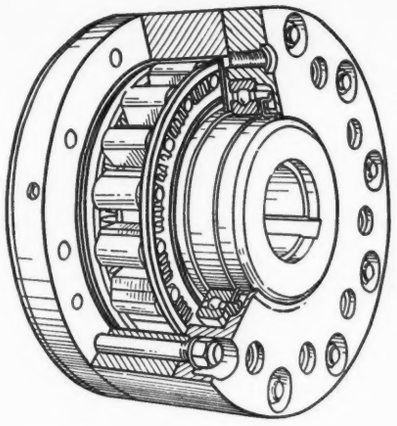
If the units are to be used for peak loads, the most economic solution of the problem would involve the use of the higher-speed standardized type of diesel operating at 1200 rpm. We have had most excellent results with this type of American-made engine, which clearly indicates that they will stand up as well as the slower-speed units, under proper operating conditions. Ten to fifteen thousand hours of operation between overhauls have not been uncommon.

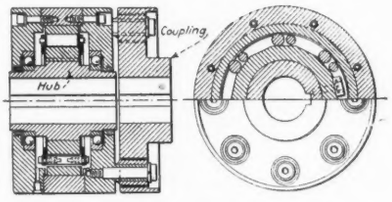
If a number of these units are to be applied, either full-automatic control or at least semi-automatic control becomes desirable. For full-automatic operation the free-wheeling clutch simplifies the problem. If used, extreme care must be taken to eliminate the transmission of torsional vibrations from engine to clutch. The straight lever-operated clutch may also be used with an automatic operating mechanism.

The governors on the diesel engines



Typical magnetic clutches





Typical over-riding clutches

should not be too sensitive for satisfactory parallel operation with not less than 5% speed variation between full and no load. They should be easily adjustable externally. In a manually operated plant, if speed of the system is constant, it would not be necessary to adjust the governor very frequently, but in any event this governor adjustment would be made in accordance with exhaust temperature of the diesels, which is a good measure of the load. With a 4-cycle engine, an exhaust temperature of 700-800 F would be about right.

In the fully automatic plant, there are several ways initial control can be obtained: (1) as a function of the speed or cycles of the system, in which case a drop in the cycles would indicate or reflect an over-load requiring operation of the diesels, (2) as a function of the exhaust pressure of the steam prime mover, with the diesel input controlled to balance demand for power and steam for process, (3) as a function of the gate-opening or head on a hydraulic turbine, or (4) as a function of the voltage.

Control as a function of voltage would be ideal for a power company that wanted to locate diesel units for peak-load operation on its network. When the voltage was up, the diesel alternators would float on the line as condensers and correct the line power factor. The moment the voltage started to drop, the diesel or diesels would be brought into operation automatically, and constant voltage could be maintained as desired.

Where two or more diesels are used in a single group, we have found that exhaust temperature offers the best medium for control in that it reflects the operating condition of the engine. The air-operated type of recorder-controller makes an ideal and flexible instrument for this purpose, with the exhaust-temperature record giving an exact operating log of each engine operation. The controllers can be arranged to adjust automatically the governors of their own engines or adjacent engines as needs require. Also, two or more diesels can be applied to a single alternator. Such a unit, built by the writer, consisting of a 1200-rpm alternator driven by two diesel engines through over-running clutches, was shown on page 52 of POWER, January, 1937. This unit has been in continuous operation for over 5 years.

The exact problem in this instance has not been stated but, as an illustration, assume that the plant in question is a steam plant with an operator on hand at all times. Arrangements could be made to start each engine by a pushbutton, as required. Each unit should have an exhaust-temperature control operating its own governor-adjustment lever, in which case it would automatically assume its full load and would require no further attention from the operator. We would suggest using 110-hp, 1200-rpm diesels as being the lowest in cost per hp. Any number of these units could be used up to the additional capacity required.

Sharon, Mass. G B BAILEY

Results Exceed Expectations

THE HOOKUP or mechanical interconnection of alternator and diesel engine is of utmost importance. This can be accomplished with any of the various types of clutches available. With power-factor correction as a deciding factor, I presume that RFN is taking precautions in selecting the proper alternator.

Unfortunately, RFN omitted to state kva of the proposed diesel-generator. For his information, I will describe operating experience with a plant of the sort he proposes to install. We had two 6000-kva diesel alternators for peak demand, operating approximately four hours a day in parallel with a 12,000-kva steam-turbine plant. If load could be carried by the turbine-alternator alone, the diesel units were disengaged from the alternators by means of a hydraulic coupling. Shutting down the diesel engines left the alternators on the line ready for use as synchronous condensers.

We accomplished up to 17% power-factor correction. Starting the diesel units and synchronizing the alternators with the steam-turbine plant was performed by two operating engineers within the 3-minute starting time guaranteed by the manufacturer of the equipment.

New York, N. Y. CARL BACHMANN

Proper Generator Must be Selected

DIESEL GENERATORS can be arranged to operate as synchronous condensers with entire satisfaction if certain simple precautions are followed. For this service the generator should be equipped with amortiseur or squirrel-cage windings to take care of starting rotation with the engine disconnected. If the generator is not equipped with amortiseur windings, it can be connected to the engine with a clutch of some sort so that the generator can be started by the engine and then the engine can be cut off.

It is important that such a clutch be designed to cut out completely so that there is no friction drag on the generator when it is running as a synchronous condenser. Any one of a number of commercially available clutches may be used for the purpose: magnetic clutches, friction clutches, or clutches of the free-wheeling or over-riding type.

Pittsburgh, Pa. FRANK HANRATTY

Corrosion in Cooling Coils

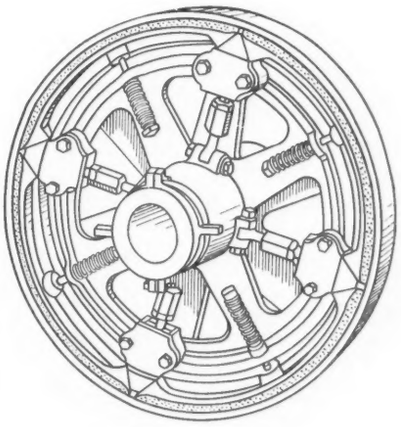
Answers to May Question 2

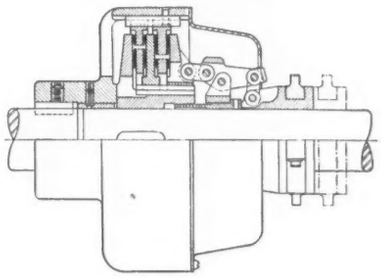
The Question

WE HAVE *in our ammonia refrigerating plant several herringbone coils for cooling calcium-chloride brine. An inspection made after leaks developed showed pitting in the electric welds at the point where the pipe-runs entered the headers. These welds were badly pitted and eaten. Acetylene welds in the same tank, and the tank and coils themselves, were in good condition. Attack had been confined to the factory-made arc welds. The coils have been in service about 7 years and pH has always been maintained near 8.0. Can any* POWER *readers suggest what is the cause of this corrosion and what can be done to prevent its recurrence?*—WFB

Wrong Weld Metal

WFB'S PROBLEM parallels one which came under my observation (and got under my skin) several years ago. Perhaps our findings at that time may solve WFB's problem of the cause of corrosion in cooling coils, even though knowing "why" may not eliminate further trouble with the same equipment. Our trouble was with the tubes





Typical friction clutches

in a heat exchanger, welded to the heads. The joints corroded badly, although the remainder of the tubes and headers showed but little evidence of electrolytic or corrosive action.

When the tubes showed excessive leakage because of this corrosion, coupons were cut from the weld and tested for analysis of the materials involved. It was found that the welding rod used was an alloy which, from the welder's angle, worked easily and rapidly, but which, metallurgically, presented one half of an electrolytic couple and greatly encouraged activity at the weld over that evident elsewhere in the heat exchangers. The only remedy was the drastic one of cutting off all tubes, removing the weld metal built up during the original manufacturing process, and welding the tubes in again with a welding rod of like or neutral characteristics in the electromotive scale.

It would have been possible, theoretically at least, to have determined the position of the weld metal in the electromotive series, and to have inserted collars, plates or special forms of a metal such as zinc close to the welded headers and thus reversed the direction of the currents generated. However, the entire group of welds was so badly pitted before the trouble developed on the outside and thus became visible that the method outlined was followed instead.

Ten years ago, the use of **proper welding** rods was interpreted by many shop welders and their field counterparts as meaning only that they found some rod which was responsive to their technique, and which allowed the operator to make good speed, without regard to metallurgical relationship between rod and metals being joined. With the great strides made in welding since that time, however, such an occurence is likely to happen only when the work is done by some shop too backward to keep up with modern practice. Users of arc-welded equipment from modern factories may be sure that the entire metallurgical balance is now regulated and carefully checked during production. All of which is of little practical help to WFB, who may be in much the same position as the buyer of an "orphan" car.

Houston, Texas ELTON STERRETT

Suggests Higher pH to Stop Corrosion

CORROSION OF IRON PARTS is best inhibited by holding the pH of the brine at about 9.5. The lower pH value in WFB's cooler was, I believe, directly responsible for the pitting at the welds. To prevent recurrence, I suggest treating the calcium-chloride brine with 55 lb of sodium dichromate per 500 cu ft. Also check and purge the system of non-condensible gases.

New York, N. Y. CARL BACHMANN

Electrolytic Action Causing Trouble

I CAN MAKE what I believe is a fairly close guess as to the cause of WFB's trouble, although long-range diagnosis is always open to error. It looks as if the weld metal, as deposited, is enough different from the base metal to cause electrolytic action. Apparently the same difficulty did not arise in the case of the acetylene welds.

WFB can check this diagnosis by cutting out a sample from a typical weld and having it checked by a competent metallurgist. It is likely that the weld metal will show up as somewhat higher in carbon content than the base metal. Differences of this kind are often sufficient to cause electrolytic action.

If this proves to be the right answer, I suggest WFB specify that the deposited metal be the same as the base metal and that necessary steps be taken to insure following this specification in the re-welding of this cooler and in the fabrication of any other similar equipment that might be purchased in the future.

New York, N. Y. C A FINCH

✦ ✦ ✦

Wrong Answer on Boiler-Tube Thickness

ON PAGE 114 of the January 1941 issue, you have a question and its answer regarding the allowable boiler pressure on a 4-in. seamless tube with a wall thickness of 0.10 in. I believe the answer given is totally incorrect and misleading.

In the first place, the ASME Code would not permit the use of a 4-in. seamless tube with a wall thickness of only 0.10 in. The minimum wall thickness allowed on a 4 in. tube is 0.135 in. for a watertube boiler and 0.120 in. for a firetube boiler.

In the second place, the formula given for computing the allowable working pressure is now obsolete and has been revised by addenda to the ASME power boiler Code approved March 1, 1940. Further, the formula for a firetube boiler is different from that for a watertube boiler.

New York, N. Y. H C CURTISS

I MUST SAY Mr Curtiss is absolutely correct in his statements.

A "Quick Answer" may often be misleading, especially so when the question is of the trick variety. I consider the question as asked, I believe in a municipal examination, as definitely misleading and open for comment. The question asks for a theoretical answer, in my opinion as the statements of fact in given data are incorrect for "Code" boilers.

Theoretically, the bursting pressure of the tube, assuming, 60,000 lb per sq in. tensile strength would be

$$\frac{2 \times 0.1 \times 60{,}000}{3.8} = 3160 \text{ lb per sq in.}$$

and, based on a factor of safety of 5,

$$\frac{3160}{5} = 632 \text{ lb per sq in.}$$

That is one strike on me, as I used round figures rather than calculating the pressure based on the inside *radius* as would be done for "thin-walled cylinders".

The ASME watertube formula referred to by Mr Curtiss is now, subject to certain qualifications at tube temperatures of over 750 F;

$$P = \frac{2.3\ St}{D} - \frac{S}{30}$$

where P = the maximum working pressure, S = stress from table (10,400 minimum for assumed tube material), t = thickness in inches and D = diameter.

Then, *if* this formula were used

$$P = \frac{2.3 \times 10{,}400 \times .1}{4} - \frac{10{,}400}{30}$$

= 252 lb per sq in.

But again it should be emphasized that as the tube is thinner than permitted by the ASME tables, it should not be used in practice.

I should have pointed out that the new formula was approved, though the new Code Book did not appear until the first of February. Also, the formula for fire-tubes is different. As the data stated 4-in. diameter, which is a little unusual for modern fire-tubes, I assumed a water-tube.

I accept a second strike, but I feel that the third strike should be reserved for the guy who formulated the question.—HMS.

Q—How much allowance is there for a safety-valve spring calibrated at 100 lb g?

A—The implication of this question is, probably, what is the permissible range of adjustment for a safety-valve spring rated at 100 lb per sq in.? The answer would be 10% of its rating or 90 lb per sq in. minimum to 110 lb per sq in. maximum.

Boiler Practice

Q—What is the maximum lift for a 2-in. safety valve?

A—A safety valve should be able to lift from its seat at least one-tenth of the seat diameter. At this lift there should be no interference from adjacent spring coils or from any other source.

With reference to maximum lift, refer to Paragraph P-272 of the ASME Code for Power Boilers. In part, this reads "Safety valves may be used to give any opening up to the full discharge capacity of the area of the opening of the valve inlet, provided the movement of the valve is such as not to induce lifting of water in the boiler." While this rule does not mention maximum lift of the valve specifically, it appears that it would apply if a valve had such a high lift as to cause priming of boiler water under otherwise normal conditions.

Q—What is the area of a safety valve on a boiler rated at 100 lb pressure, 400 hp, operating at 250% rating and 1.03 factor of evaporation?

A—This question would have been answered, according to methods used in past years, by the formula:

$$W = 110 \times P \times D \times L$$

where W is discharge capacity of safety valve in lb per hr, P is absolute pressure at which the valve is set (gage pressure plus 14.7 lb per sq in.) D is inside diameter of seat in inches, and L is vertical lift of valve in inches.

The total output of the boiler at 250% rating will be:

$$400 \times \frac{34.5}{1.03} \times 2.5 = 33{,}495 \text{ lb per hr}$$

At least two safety valves are required for a boiler with a capacity of over 2000 lb per hr or over 500 sq ft water-heating surface. Thus the value of W for each valve is half of 33,495 or 16,748 lb per hr. Selecting a 4-in. safety valve, we solve for minimum lift by transposing the above formula:

$$L = \frac{16{,}748}{110 \times P \times D} = 0.33 \text{ in.}$$

Area $= 3.14 \times 4 \times 0.33 = 4.14$ sq in.

According to the latest method of selecting safety valves, the *actual* discharge capacity, as found by test and stamped on the valve, is used.

In the question given, it is assumed that a stoker-fired watertube boiler is involved. Here the Code requires a minimum discharge capacity of 8 lb per hr per sq ft of boiler heating surface. Thus, at 10 sq ft per hp, we have a total surface of $400 \times 10 = 4000$ sq ft, and $4000 \times 8 = 32{,}000$ lb per hr total relieving capacity required for the boiler.

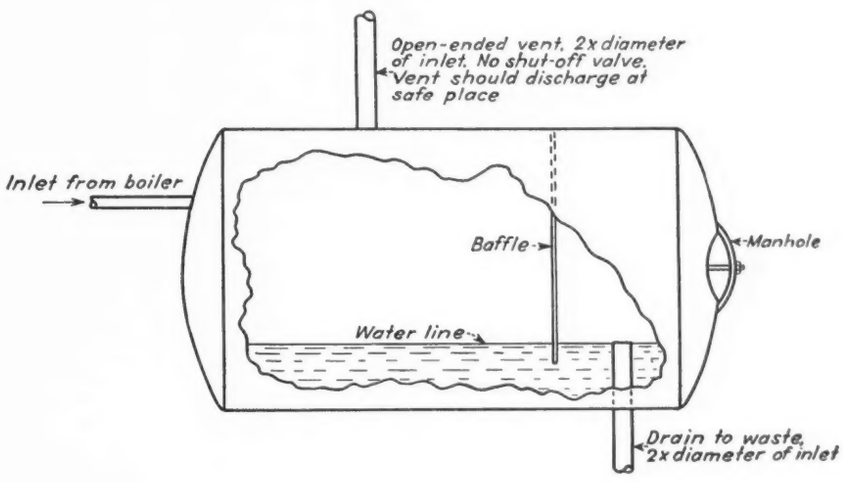
The adequacy of this should be checked by an accumulation test to see if additional capacity is needed. This is done by closing all steam outlets except the safety valves and forcing combustion to the maximum. The safety valves should prevent the pressure from rising more than 6% above the highest pressure at which any valve is set, but in no case more than 6% above maximum allowable working pressure.

Q—Where does the feedwater enter an hrt boiler less than 36 in. in diameter?

A—A boiler bushing should be used and located either in the front head, just above the tubes, or in the top of the shell about 3/5 of the way toward the rear. An internal pipe should be attached to the bushing. In cases where the bushing is in the front head, this pipe should be 2 or 3 ft long. If the bushing is in the shell, the internal pipe should terminate about an inch above the tubes. It is suggested that the internal pipe be welded or otherwise permanently attached to the bushing.

Q—Sketch a blowoff receiver showing connections and relative sizes.

A—The accompanying drawing shows a typical construction. It is recommended that the tank have a capacity equal to 1/5 of the water capacity of all boilers that might be blown down simultaneously. Most codes in this country are silent as to construction and materials. The Interprovincial Boiler Code in Canada requires that a blowdown tank be constructed for a pressure at least as high as the highest pressure allowed on any boiler connected to it.


Open-ended vent, 2x diameter of inlet. No shut-off valve. Vent should discharge at safe place
Inlet from boiler
Baffle
Manhole
Water line
Drain to waste, 2x diameter of inlet

Q—What is meant in the ASME Code for Power Boilers by "safe-ending" of boiler tubes?

A—Safe-ending is a process whereby deteriorated ends of fire tubes are cut off and replaced by short lengths of new tubing. The abutting ends may be forge-welded, after belling one end and swaging the other, or they may be joined by fusion welding. The latter process is usually performed by electric-resistance butt or "flash" welding after the parts have been sandblasted.

Q—Is it permissible to use, in a water-tube boiler, tubes that have been re-ended by fusion welding?

A—The terms "re-ending" or "safe-ending" apply mainly to fire-tube boilers where it is not uncommon for deterioration of tube ends to take place. This is not common in water-tube boilers. Certain field changes in design and other field problems may make use of a circumferential weld in a water tube desirable. The Code permits this with limitations as to diameter, thickness, location of tube, and procedure. These limitations, for tubes exposed to radiant heat (having less than five rows of tubes between the furnace and the tube to be welded), are 4 in. maximum outside diameter and ½ in. maximum wall thickness.

Figuring Water Heating

By PHIL SWAIN

FROM ONE ANGLE or another every power engineer is interested in water heating. This article will show how much steam is required to heat water.

A more difficult question, often asked POWER's editors, is how many square feet of steam tubing are required to heat such and such a quantity of water to such and such temperature. There is generally no way to get a reliable answer to this except by cut and try with actual tubing. The reason is that the coefficient of heat transfer from steam through tubing to water varies several hundred percent according to the particular arrangement of the coil, water movement, etc.

Easy to Figure

On the other hand, as already indicated, it is easy to figure the amount of steam required for water heating. For many purposes the round-figure allowance of 1000 Btu per pound of steam is close enough.

Suppose, then, you want to heat 5780 lb of water from 60 F to 180 F. The rise is 120 degrees, so the water absorbs 120 Btu per pound, or a total of 5780 x 120 = 693,600 Btu. If each pound of steam supplies 1000 Btu, the steam required will be 694 lb. This, of course, takes no account of the heat required to warm up the metal of the tank or the heat lost from the tank and the water surface during the heating-up period.

Now let's refigure this problem using actual steam-table data instead of the round 1000 Btu per pound. Total heat ("enthalpy") of saturated steam at 5 lb gage (20 lb abs) is 1156 Btu per pound. Amount of heat transferred to water is this minus heat in condensate at its final temperature. This in turn depends on the method of heating.

Consider the case where the water is heated by direct contact with the steam (Fig. 1). Here final temperature of the condensate must be 180 F and its final heat ("enthalpy") 180 — 32 = 148 Btu per lb. Then the heat given up per lb of steam will be 1156 — 148 = 1008 Btu per lb. Steam required to heat the 693,600 lb of water will then be 693,600 ÷ 1008 = 688 lb.

If you want to correct this for the heat required to warm up the tank, it's not difficult, assuming that the metal starts at 60 F and rises to 180 F just like the water. If the metal is iron, steel, brass or copper its heat-absorbing capacity (specific heat) is about one tenth that of water, so all you have to do is to add one tenth the weight of tank to the weight of the water contained.

Equivalent weight of water would then be (for a 850-lb steel tank) 5780 + 85 = 5865 lb, the heat absorbed 5865 × 120 = 703,800 Btu, and the steam required 703,800 ÷ 1008 = 698 lb, practically the same as figured before.

As another example, consider Fig. 2 showing 5780 lb of water per hour heated by 10-lb (gage) steam supplied to a submerged coil. Here the tank is maintained continuously at 200 F, new water being fed in at 60 F to replace the 5780 lb per hr drawn off at 200 F. In this case the heat capacity of the tank makes no difference, since its temperature does not change.

The amount of heat given up per pound of steam will depend upon the cooling of the condensate. If condensate leaves at 10 deg above water temperature its temperature will be 210 F and its heat (enthalpy) 210 — 32 = 178 Btu. Then heat given up per pound of steam will be 1160 — 178 = 982 Btu; steam required per hour = 5780 × (200 — 60) ÷ 982 = 824 lb.

If the tube is well insulated against heat loss, the arrangement shown in Fig. 3, or some equivalent, gives the greatest efficiency, because it cools the condensate down almost to the temperature of the entering cold water—let's say within 10 degrees. Then condensate leaves at 70 F, with 70 — 32 = 38 Btu, and heat given off per pound of steam is 1160 — 38 = 1122 Btu. The steam required to heat 5780 lb per hour will be 5780 × (200 — 60) ÷ 1122 = 721 lb.

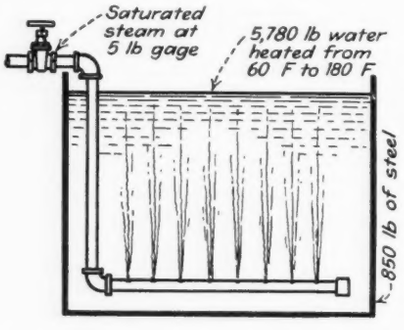


Fig. 1—Heating by mixing. Heat supplied per lb of steam is difference between total heat of steam supplied and that of condensate at 180 F

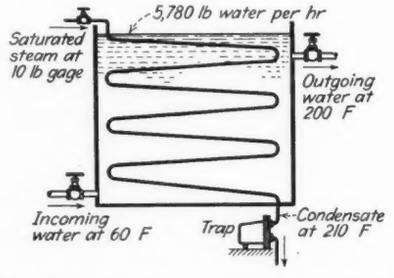


Fig. 2—Heating by coil in tank. Heat supplied per lb of steam is difference between total heat of steam supplied and heat of condensate at its discharge temperature. In this arrangement, condensate would be higher than 200 F

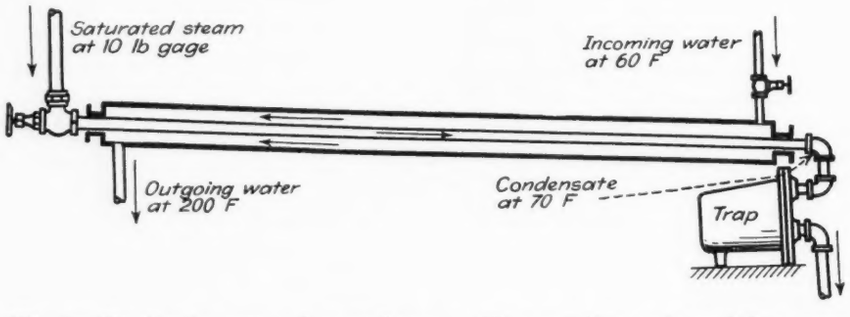


Fig. 3—Heating in counterflow exchanger. Here condensate is cooled to temperature of cold feedwater so heat given out per lb of steam is much higher than in Fig. 2, a gain of about 140 Btu per lb of steam

ARGUMENT CORNER

Did You Mean It When You Said . . . ?

QUITE EVIDENTLY the enlightening educational efforts of the National District Heating Association have failed to reach your inventive reader RNG who submitted the unusual device for metering condensate pictured in your April, 1941, issue, page 101.

After reading the accompanying description I was not sure whether you and your reader were seriously proposing the idea or whether you were just indulging in a bit of subtle humor. You suggested several of the many reasons why the proposed device would be impracticable, complicated and expensive. Inasmuch as you asked for it, your readers will probably write giving you a number of detailed things wrong with it.

Any of your readers who are really interested in obtaining accurate, convenient, inexpensive, compact and trouble-free steam condensate meters should write to the Central Station Steam Co, 2910 E Woodbridge St, Detroit, Michigan. They have thousands of condensate meters in operation on district heating and other installations throughout the United States. They have been in business for many years and have the specialists' knowledge and equipment to design and to produce a real meter at a reasonable cost.

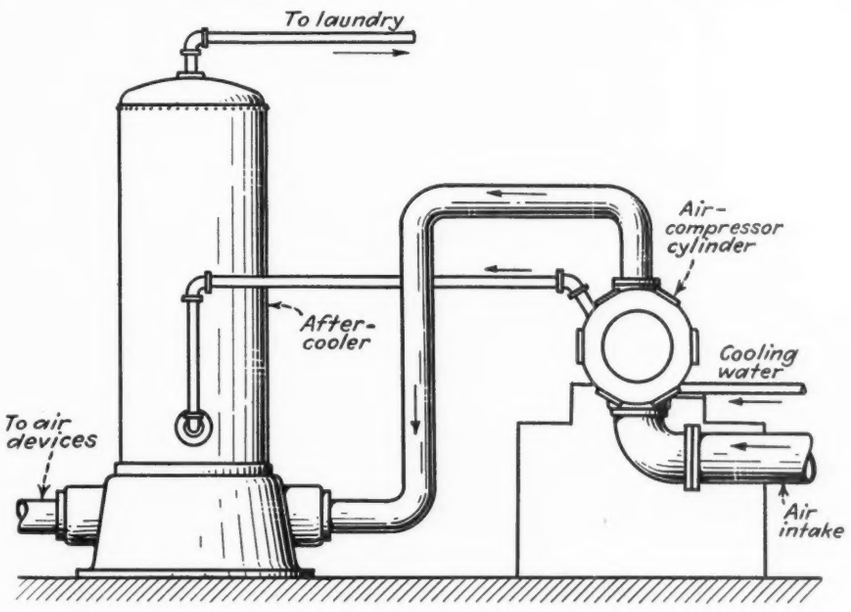
A laboratory director or a plant engineer with surplus time on his hands might have fun playing with such a novel contraption as you picture. Others would not want to be responsible to their management or to their customers for accurate measurement with the proposed meter under actual job conditions.

Rochester, N. Y. L S

Improvement on Cooling-Water Hookup

I WANT TO COMPLIMENT Thomas Wood for his article on page 97, May POWER, in which he shows not only how water consumption was reduced by running it in series through the air-compressor jackets and the aftercooler, but also how to use the water to reclaim the heat for laundry use. He has shown considerable resourcefulness.

The sketch (as originally published, below) shows the cooling water running first to the compressor jackets and then to the aftercooler. I would suggest that the flow be reversed so that the coldest water enters the aftercooler, thus more water vapor would be condensed from the air. Mr. Wood would then still have series flow as the water would pass from the aftercooler to the jackets and then to the laundry.



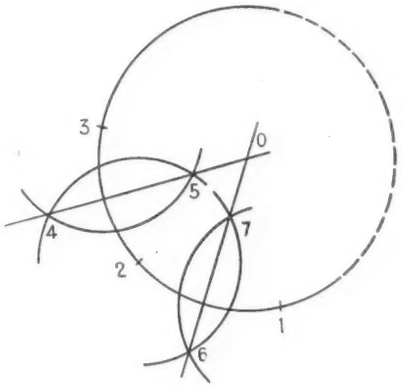
Rochester, N. Y. E W JOHNSTON

Better Method for Finding True Center

THE METHOD for finding the center of circular plates and flange heads recommended by HMS in January POWER (page 107) seems to be alright if circumference is true and none of the plate is missing, which is not often the case.

The writer has found that the accompanying drawing shows a more practical method. For the sake of simplicity, let's say that the dashed portion of the drawing represents that part of plate which is missing or circumference that is untrue.

Mark off points 1, 2 and 3 well apart on the true portion of the circumference. With 1 and 2 as centers, draw two arcs of the same radius intersecting at points 6 and 7. With 2 and 3



as centers, draw two arcs of equal radius intersecting at 4 and 5. Through intersections 6 and 7—4 and 5, draw lines 6-7 and 4-5. The lines will intersect at 0 which is the center of the circle because a line through the center of a circle is always perpendicular to the circumference at the point where it crosses the circumference. We have drawn 6-7 and 4-5 perpendicular to the circumference.

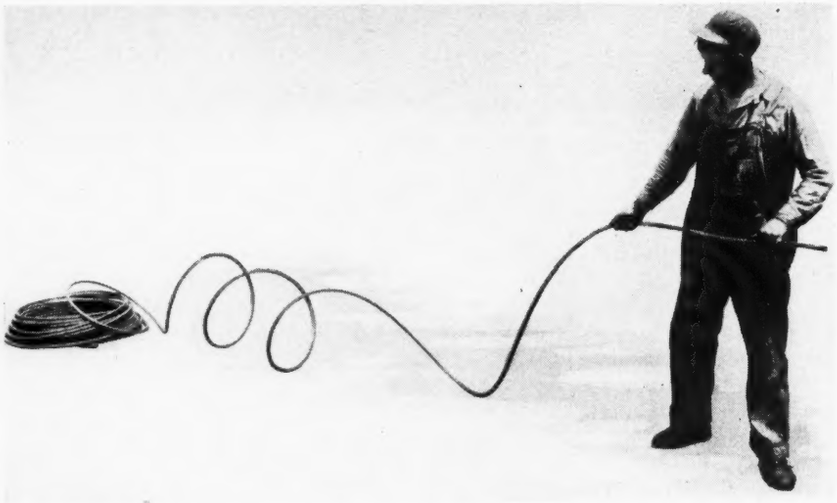
A piece of chalk and a string and straight edge can be used to this job very well, yet dividers and scribers are handy tools to have on hand for this and many other jobs.

Chicago, Ill. WILLIAM W BELL

Editor's Note: This method is geometrically exact. To get a good intersection at O the angle 4O6 should preferably be somewhere near a right angle, say not less than 70 degrees and not more than 110 degrees.

HOW TO HANDLE WIRE ROPE

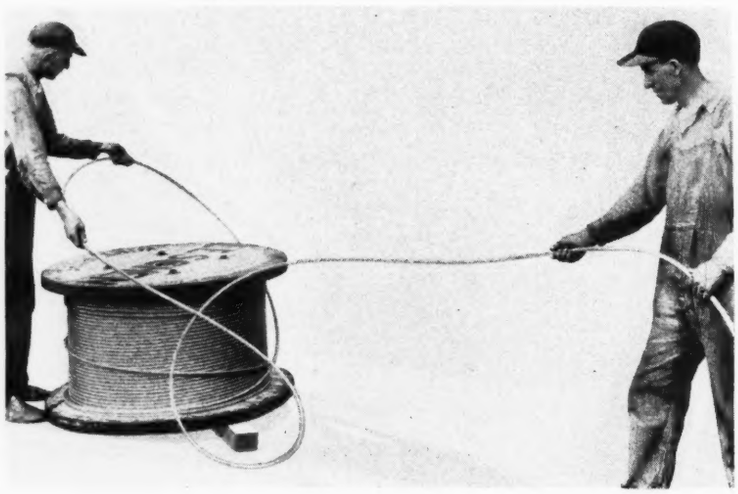
WIRE ROPE has a tendency to kink under improper handling and once kinked is practically impossible to straighten. Kinking, which reduces the useful life of wire rope, can be prevented by proper care in handling and installing, as shown by the photos below supplied by A Leschen & Sons Rope Co.



1 Wrong way to take wire rope off a coil or roll. Do not pull wire rope off as you would hemp rope, for the wire will loop and will kink if pulled taut

2 Right way to take wire rope off coil or roll. Place the coil on edge and roll it along the floor or ground—the rope will lie straight. If the rope is to be recoiled, reverse the operation

3 ↓ Wrong way to take wire rope off a reel. Do not lay the reel flat and throw off one turn after another—you will probably damage the rope and cause short life



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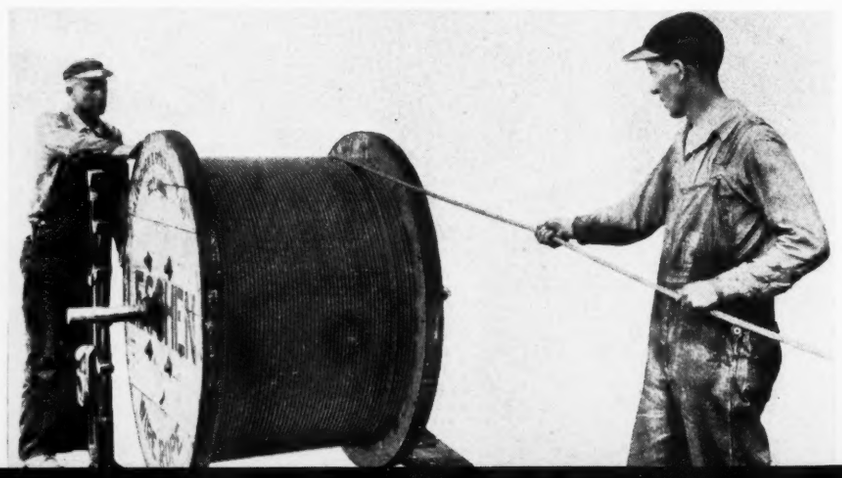
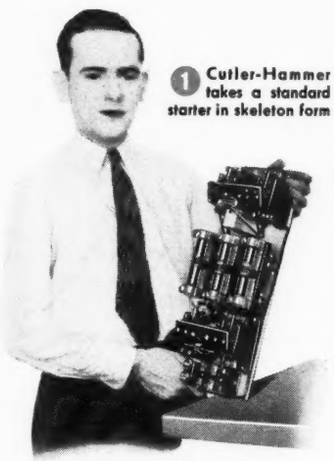
Right way to take wire rope off a reel. Mount the reel so that it can revolve and then slowly pull the rope out straight as the reel revolves. When taking rope off a reel to put on a drum it is good practice to have the rope wrap onto the drum in the same direction it was wrapped on the reel. For example, if the rope overwinds on the drum, it should be taken off the top of the reel; if it underwinds on the drum, arrange the reel so that the rope pulls off the bottom of the reel

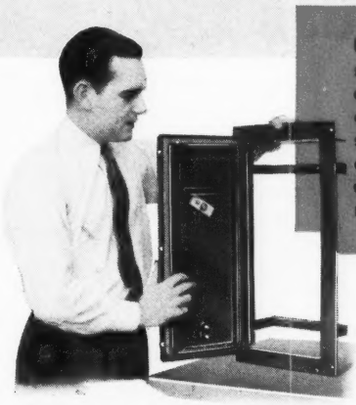


How to SAVE TIME AND MONEY *in building Motorized Machines*

UNITROL is a new and better answer to questions such as: how big to cut the cavity? how to mount and wire the control? what about the door, the closure and the disconnect switch handle? how to save space, time and money on multi-motored machines? how to install a number of controls behind a single door? and many others. This time and money saver is described in a 64-page, fully illustrated book sent free to executives.



1 Cutler-Hammer takes a standard starter in skeleton form



2 . . . adds a new "universal" UNITROL mounting frame with hinged front door

3 . . . fastens starter in UNITROL frame

UNITROL . . . a major Motor Control development pioneered by Cutler-Hammer . . . is a new more versatile solution of *all* problems of Motor Control installation and mounting. But now builders of motorized machines are beginning to recognize it as a *special* solution of *their* troubles . . . because it offers them simplified, more speedy assembly and important reductions in cost. Significant, are the number of expensive manufacturing operations eliminated entirely; standardized interchangeability is now an assured fact; important new advantages in inspection and servicing are brought to the customer.

Unitrol can be used where there is only one motor, where there are several motors, where there is an entire battery of duplicate machines. In every case, Unitrol brings manufacturing economies, valuable space economies, installation economies and servicing economies. Get the full story of this pioneering advance in Motor Control methods—the 64-page book "UNITROL . . . the Next Step Forward in Motor Control Progress." It's free. Simply write for your copy NOW. CUTLER-HAMMER, Inc., 1358 St. Paul Avenue, Milwaukee, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

Copyright 1941, Cutler-Hammer, Inc.

4 You simply insert the "Unitrol Unit" in place in your machine

5 Presto! Your built-in control is complete. All parts accessible, wiring is easy

CUTLER·HAMMER
UNITROL
C·H

New Facts on High-Temperature Gas-Engine Cooling

Manley H Clark* cites experience and tests to show that jacket temperatures of 212 F, and over, do not adversely affect engine parts or lubrication, and that ability to recover all available heat in form of low-presssure steam offers real advantages in industrial plants

▶ THREE FACTORS have been responsible, to a large degree, for the increase in gas-engine application over the past ten years: (1) development and perfection of the moderate-speed, multi-cylinder industrial engine for operation with natural gas, (2) improvements in methods of heat recovery, and (3) development of new and better methods of absorption refrigeration.

Moderate-Speed Engines

Moderate-speed multi-cylinder engines, originally designed for portable industrial service using liquid fuel, were first seriously promoted for stationary natural-gas operation early in 1931. Since then lubrication problems have been largely overcome, improvements in design insure longer life for ignition equipment and for cylinder blocks and liners, new bearings and bearing materials practically eliminate troubles in connecting-rod and main bearings, and improved carburetors give better economy under varying loads. Automatic operation, including starting and stopping and speed control, makes these engines particularly suitable to applications where a wide variation in operating conditions is encountered, as for example, in water pumping, or in refrigeration or air-conditioning work where compressor output is controlled by speed variation.

These moderate-speed engines do not supplant the older horizontal and vertical heavy-duty types, which now constitute 70% of the connected gas-engine load in the U. S. Moderate-speed multi-cylinder engines, with their low first cost, compactness, flexibility, and simplicity, open a new field to gas-engine power.

Recently, extensive efforts have been directed toward greater recovery of waste heat from gas engines. Fig. 1 shows the amount of heat recoverable from the different parts of the engine system. The engine jacket water represents the greatest amount but with conventional cooling temperatures of from 100 to 160 F, equipment required to recover this heat is elaborate and expensive. Moreover, the heat can only be used for space or domestic water heating because of its low temperature. Thus, waste-heat recovery has been largely confined to special exhaust manifolds and exhaust-gas boilers. This means loss of the major portion of the recoverable heat in cases where variations in power demand and heat requirements preclude use of jacket heat for preheating water supplied to the exhaust-gas equipment.

When the idea of cooling engines with water at 212 F, and over, was first suggested, it immediately became apparent that this method would make available all recoverable engine heat, at commercially usable temperatures, and would make it possible to maintain a uniform engine heat balance regardless of fluctuations in power or heat loads. The shaded projections at the right of Fig. 1 show the advantage gained.

(*Continued on page 116*)

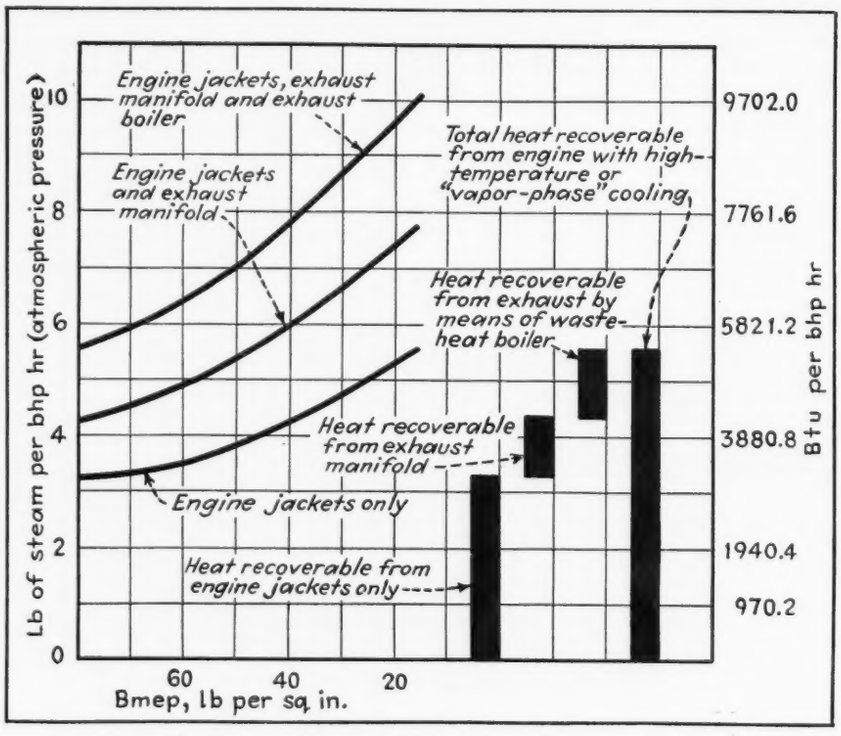
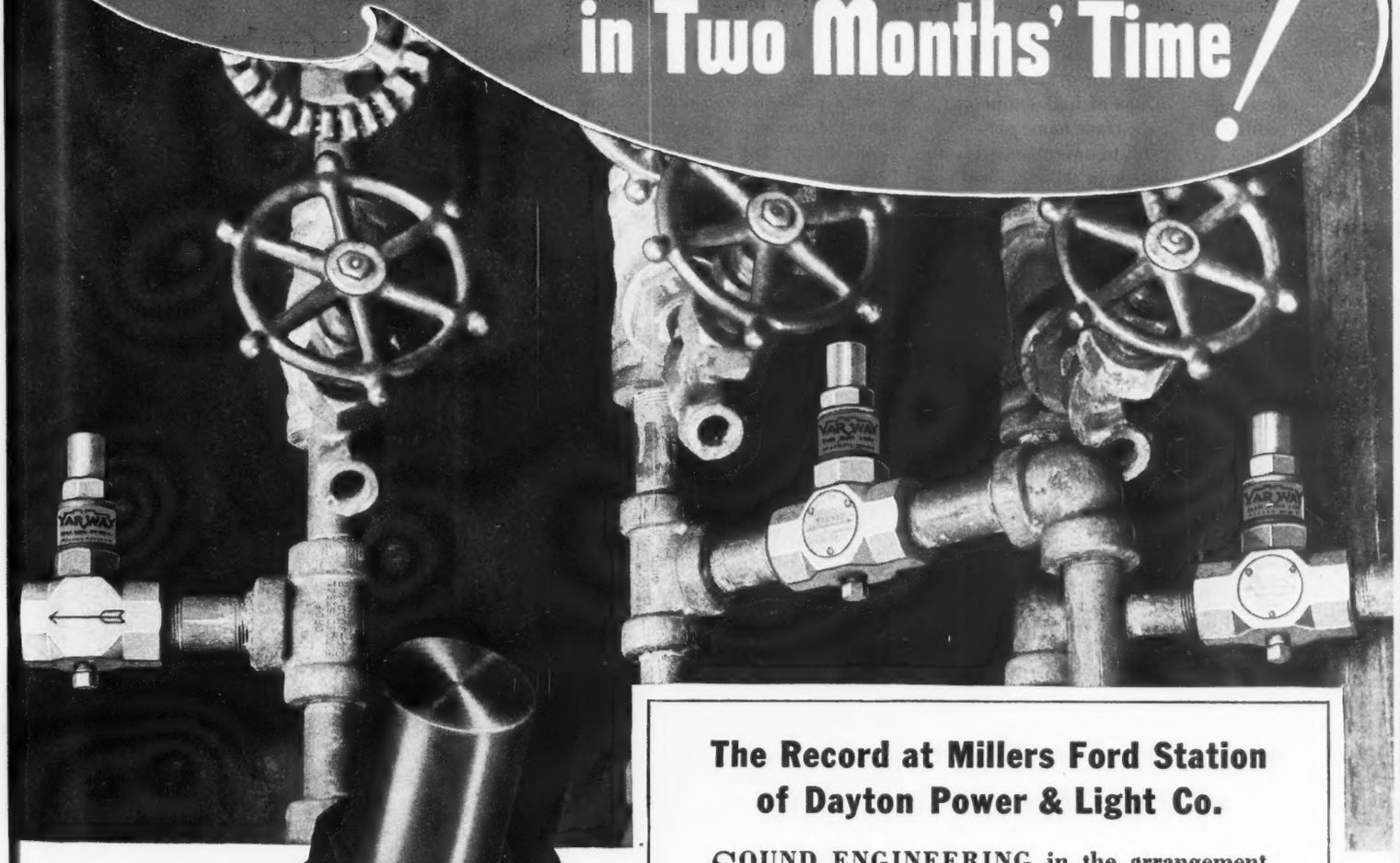
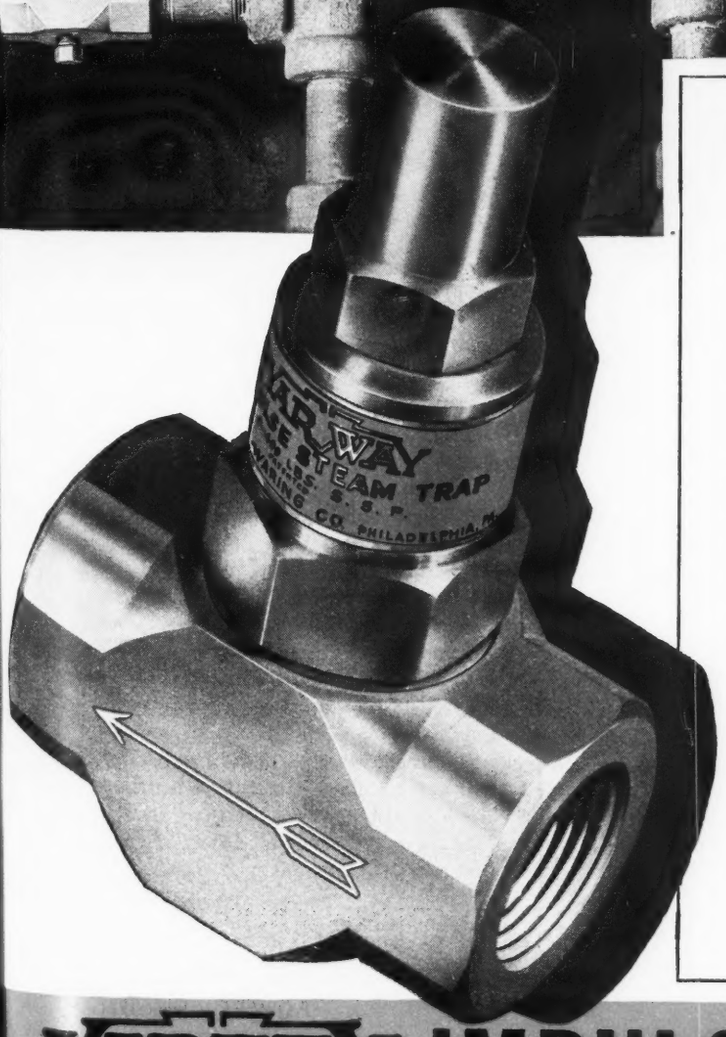


Fig. 1—Heat recoverable from different parts of a natural-gas engine

* Southern Counties Gas Co. of Calif.; chairman, American Gas Association Gas-Engine Power Committee. This article abstracted from a paper "What's Happening in the Gas-Engine Field", presented at the Industrial Sessions of the American Gas Assn. National Gas Convention, Dallas, Texas, May 6, 1941.

48 YARWAY IMPULSE TRAPS *Saved the Entire Cost of Their Installation* in Two Months' Time!





The Record at Millers Ford Station of Dayton Power & Light Co.

SOUND ENGINEERING in the arrangement for recovery of feed water, and 48 YARWAY IMPULSE STEAM TRAPS, are *saving large quantities of expensive evaporated make-up water per day* at Millers Ford Station.

These traps, which operate at 600° F and 250 lbs pressure, are installed on the superheater drains, eight to each of their six boilers. Because they discharge against back pressure, condensate can be returned directly to the feed water heater. The superintendent states: "In two months we saved the cost of the traps, the cost of all piping and installation labor. We like them a lot."

So will you. Yarway Traps are a big help to operators of all kinds of steam equipment. They save valuable space, simplify installation and maintenance. And since their purchase price is usually less than the cost of repairing an old-type trap—why not get Yarway performance for your money?

See your supply house or write for Catalog T-1735.

YARNALL-WARING CO., 100 Mermaid Ave., Phila.

YARWAY IMPULSE STEAM TRAP

New Facts on Gas-Engine Cooling

(Continued from page 114)

Cooling of engines at 212 F, and over, is not a new idea. It has been used in Europe for a number of years; several attempts to perfect such a method in the United States met with only moderate success until 1939, when the Pacific Enterprise Products Co, of Los Angeles, developed a means of high-temperature cooling, under the trade name of "vapor-phase" cooling, to overcome severe sludging conditions in their oil-field engines operating on "sour gas" from wells. Since that time, Mr J H Wallace of that company has devoted most of his time to perfecting this process for general application.

Three Questions

When high-temperature cooling is suggested, three questions invariably arise: (1) What effect will cooling at higher temperature have on the working parts of the engine? (2) How will engine lubrication be affected? (3) How will temperature of surrounding atmosphere be affected?

Tests in the Pacific Enterprise Co's laboratory indicate that the "hot-zone" temperatures in an engine remain constant regardless of the temperature of the surrounding cooling liquid, under uniform pressure and engine load. The hot-zone is that part of the combustion chamber above the upper travel of the top piston ring at the ignition point. Surface temperature of this zone averages between 550 and 600 F. This temperature will stay the same regardless of jacket-water temperature or rate of circulation and is dependent only on boiling point of the water and heat in the combustion chamber.

Experiments conducted in the Pacific Enterprise laboratory on March 19, 1941, prove these points. These tests showed that metal temperature remained constant at 240 F as jacket-water temperature increased from 100 to 212 F. Fig. 3 shows how metal temperature increased in direct proportion to increase in the boiling point caused by raising jacket-water pressure. Thus, it seems reasonable to assume that temperature of the internal, working parts of an engine cooled at 212 F will be no higher than if conventional cooling were used.

Contrary to expectations, high-temperature cooling seems to simplify lubrication. Sludging is completely eliminated and a marked increase in mechanical efficiency indicates a reduction in "oil drag" in the cylinders. This does not mean that all oils will provide satisfactory lubrication any more than is the case with conventional cooling. However, commercial oils, available at standard prices, will give excellent results. Improved lubrication is also reflected in the decrease in cylinder wear noted in engines which have been periodically inspected during two years of operation with high-temperature cooling.

The average stationary engine is equipped with water-cooled exhaust manifolds and insulated exhaust lines leading to the outside. In such cases, only heat radiated from the engine surfaces has any practical effect on engine-room temperature. In practice, it is not possible to determine, from casual observation without aid of thermometers, whether an engine is being cooled at 212 F or a much lower temperature.

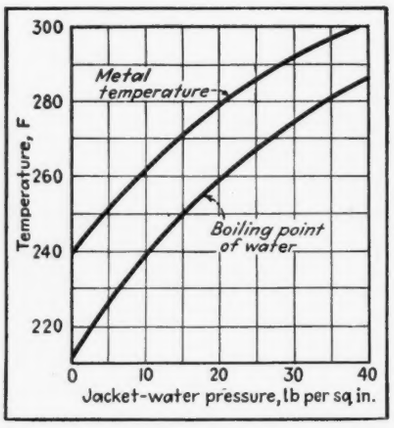


Fig. 2—Variation in metal temperature with change in jacket-water pressure

A typical example of the industrial possibilities of high-temperature cooling is the new installation at the citrus-packing plant of the Glendora Citrus Association, Glendora, Calif. The precooling section of this plant included a motor-driven ammonia compressor with automatic start-and-stop operated from head-pressure variation, and motor-driven brine and tower pumps, agitator, and blower. A large number of small electric motors powered the packing-houses equipment and steam from a gas-fired boiler heated the wash-water and the sweat rooms.

A new natural-gas power plant, equipped for high-temperature cooling and heat recovery, has just gone into operation. Two heavy-duty Western gas engines drive Electric Machinery alternators to provide power for packing house, precooling auxiliaries, and lights, while another similar unit drives the ammonia compressor. A small gas-engine-driven Witte lighting plant acts as standby for lighting when the packing house shuts down. The generators are equipped for automatic synchronizing and the engine driving the compressor has modulating speed control actuated through temperature variation in the cold rooms. Automatic safety devices and controls eliminate need for constant trained attendance.

Cooling water passes through engine

(*Continued on page 118*)

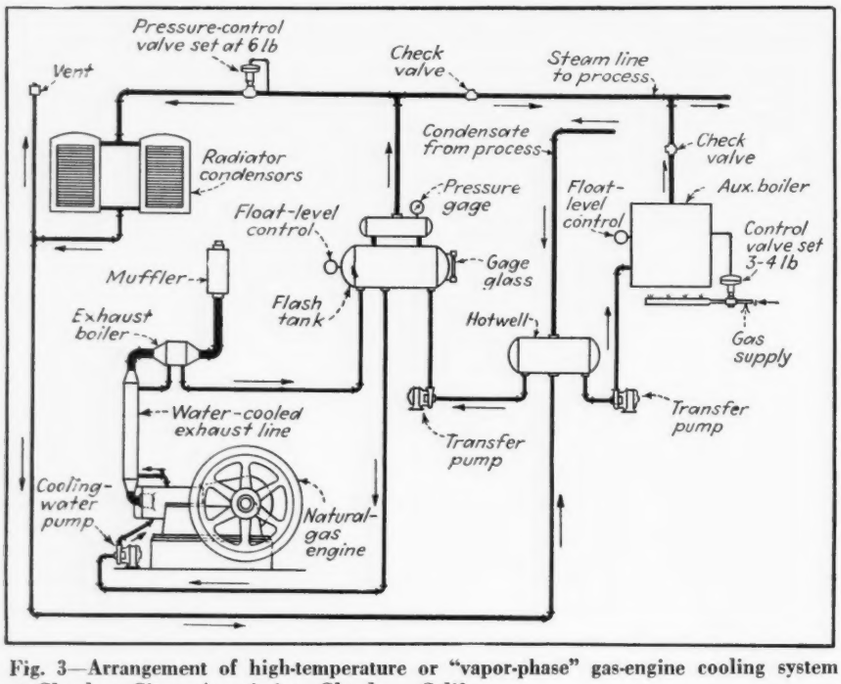


Fig. 3—Arrangement of high-temperature or "vapor-phase" gas-engine cooling system at Glendora Citrus Association, Glendora, Calif.

WHERE BOILER *Corrosion* AND *Scale* ARE WELCOME!

One of four experimental boilers in the Nalco Laboratories, operating at pressures up to 1,000 lbs. per square inch. Photo in Nalco Laboratories.

Right! Nalco Engineers test new feedwater treatments in this miniature boiler. Scale and corrosion are welcome here, because they can then be eliminated from the most difficult feedwaters without costly experimentation in your plant.

This is only one part of the complete Nalco Service—your assurance of *permanently* satisfactory feedwater treatment—with the resultant savings in fuel, maintenance and time.

Write today for complete data on the Nalco System for your particular plant requirements.

Nalco - the Complete Water Treating Service

NATIONAL ALUMINATE CORPORATION

6222 West 66th Place. • Chicago, Illinois

Canadian inquiries should be sent to ALUMINATE CHEMICALS, LTD. (ALCHEM), 555 Eastern Ave., Toronto, Ontario.

New Facts on Gas-Engine Cooling

(Continued from page 116)

jackets, then to the "water leg" or jacket surrounding the exhaust line for a distance of 8 ft, and then into Drayer and Hansen fin-tube heat exchangers mounted in the exhaust line directly following the water leg. Water from all three engine heat exchangers then flows to a common flash tank, which supplies coils in the wash tank and sweat rooms, in the packing house 400 ft away. Condensate returns to the hotwell and then feeds back to the engine jackets.

The old gas-fired boiler now rides on the steam line with a modulating burner control set to cut in when demand for packing house steam exceeds capacity of the engine heat-recovery system. When system capacity exceeds packing-house requirements, steam bypasses to air-cooled Modine condensers from where condensate flows back to the hotwell for recirculation.

Accurate Operating Data

To obtain accurate operating data, meters were installed for gas, power, light, and steam, and arrangements made to permit obtaining temperatures throughout the system. Two 12-hr test runs, during repairing packing house operation, show: (1) approximately 55% of the fuel's heating value recovered as steam at 6 lb g, with engines operating at 55 lb bmep, (2) 5920 Btu per bhphr recoverable, comparing favorably with Fig. 1, (3) 18,258 Btu per kwhr at the switchboard, with generators at 65% load, engines at 55 lb bmep, and using a short-center belt drive between engine and generator.

(4) 10,500 Btu per hphr for the engine driving the compressor, at 60 lb bmep, (5) approximately 23.8% thermal efficiency for the engines operating under these reduced average load conditions, (6) reduction of exhaust temperature from 1160 F at the ports to 250 F at boiler outlet, (7) 94% quality of steam, generally satisfactory for commercial purposes.

A heat balance, for the generating units only, shows net power output to be 18.67%, generator and transmission losses to be 4.95%, waste-heat recovery 54.95%, stack loss 13.63%, and friction, radiation, and unaccounted-for losses 7.8%. The low friction and radiation value is attributable to thorough insulation of the entire vapor-phase system and to reduction in oil drag, resulting from high-temperature cooling. Reduction in mechanical losses which may be anticipated with high-temperature cooling has been indicated in dynamometer tests at the Enterprise engine factory as being approximately 25%, compared with engines cooled at 160 F.

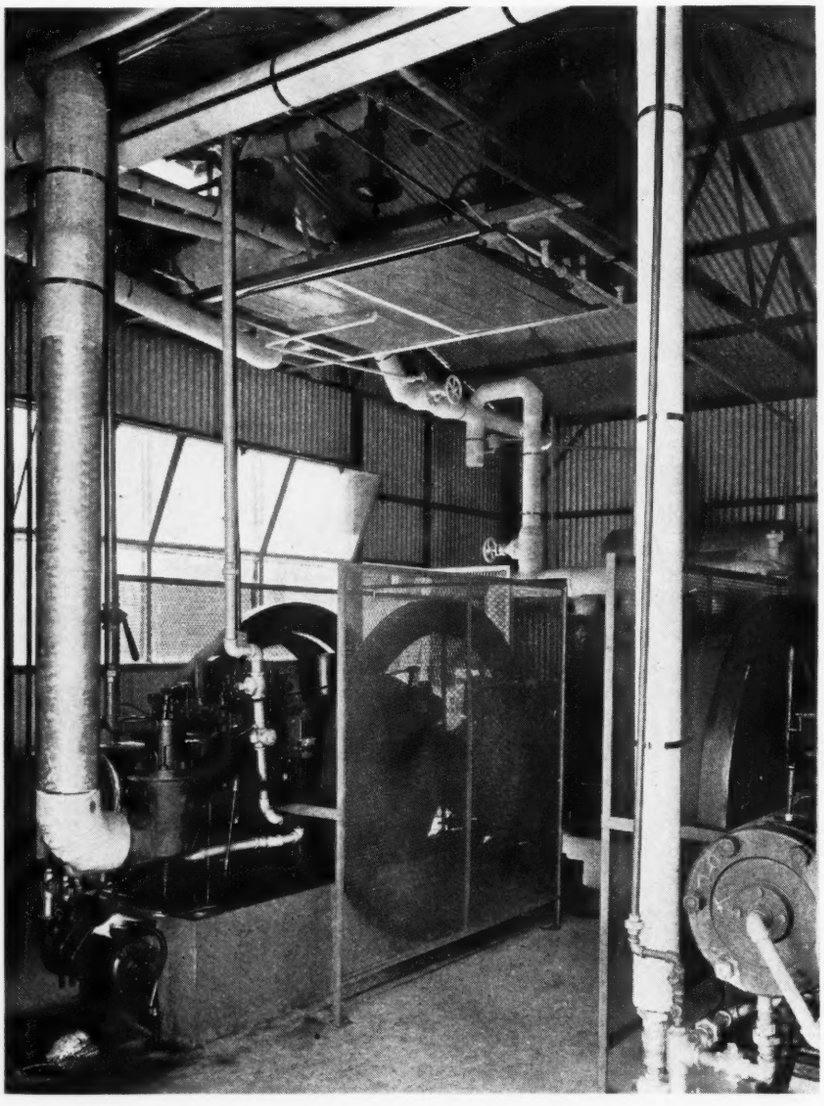


Fig. 4—Installation at Glendora: water-cooled and insulated exhaust pipe (left foreground), flash tank (upper left), air-cooled condensers (upper right), gas-fired boiler and hotwell (right rear), and condensate-return line (right foreground)

Consideration of the multitude of industrial power prospects where heat is required in some form or another will provide an idea of the great importance of this new development in waste-heat recovery. The principle may be used anywhere that power and steam represent major items in the list of plant requirements; laundries, creameries and dairies are typical examples where substantial savings in operating cost may be effected.

Glenn Miller, Southern Counties Gas Co, Los Angeles, reports several interesting developments in absorption refrigeration which can be united with high-temperature engine cooling to increase over-all operating economy. For example, where engines drive generators for power production, it is customary to use recovered heat for building heating, in the winter. Improved absorption-refrigeration machines, utilizing low-pressure steam as produced by a vapor-phase cooling system, permit waste-heat to be used for summer air-conditioning as well.

A modern absorption refrigeration machine employs methylene chloride as refrigerant with a high-boiling-point organic compound as solvent; the unit is hermetically sealed. The machine requires approximately 20 lb of steam, at 10–13 lb g, to produce one ton of re-

(*Continued on page 140*)

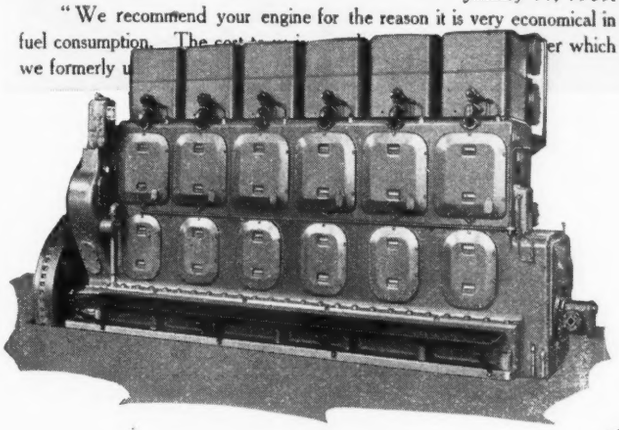
RIMES & RINKLES OF 1909

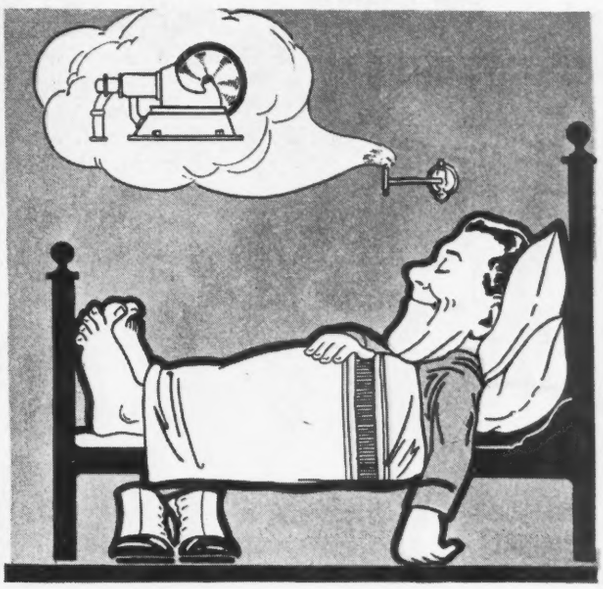
By De La Vergne

When day is done he shuts the valve,
And quickly hies him hence.
No fires to bank; No coal to burn
Through the long night without return,
With these Oil Engines De La Vergne.
They're built to save expense.

Report from Albany Hardware Specialty Mfg. Co., Albany, Wis.
January 11, 1909.

"We recommend your engine for the reason it is very economical in fuel consumption. The cost to ... er which we formerly u...





Our man each night enjoys the rest
His daily labors earn.
For him no midnight toils and cares;
He knows how well his engine wears.
They run for years without repairs,
These Engines De La Vergne.

Report fro... Library, Southport, Conn.
January 29, 1909.

"Your Engine ... 1898. It has never needed a single ... rfect satisfaction and ease."

These pages, reproduced from an early De La Vergne advertising piece, indicate the important part played by De La Vergne in the development and promotion of oil engines. De La Vergne diesel engines of today incorporate the cumulative result of forty-eight years of research and development.

Baldwin De La Vergne SALES CORP.

SUBSIDIARY OF THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA

BLW THE BALDWIN GROUP

POWER LINES

Boiler Assn Reelects Knobloch and Daniels

The American Boiler Manufacturers Association and Affiliated Industries, at their meeting June 1 to 4 at Skytop, Pa., reelected president E T Knobloch (Union Iron Works) and vice-president F H Daniels (Riley Stoker Corp). A C Baker, secretary-treasurer for many years, was continued in office. J P H deWindt (National Bureau of Casualty and Surety Underwriters) was reelected chairman of the associate members—companies concerned with accessories, insurance and other matters associated with steam generating units.

E T Knobloch

As has been customary for many years, this, the 53rd Annual Meeting of the ABMA and AI, was held in the spacious Skytop Lodge, high in the Poconos of Pennsylvania. Mornings were devoted to business sessions, afternoons to golf.

F H Daniels

Among the golf first prizes awarded at the annual dinner were: Kickers Handicap, George F Felker (Crosby Steam Gage and Valve Co); Associate Members 18-hole, C M Daniels (Bethlehem Steel); Active Members 18-hole, J H Sengstaken (Air Preheater Corp); 36-Hole Low Gross, Paul B Huyette Trophy for Associate Members, J E Fleming (National Tube Co); 36-Hole Low Gross, E H Wells Trophy for Members, E V Quinn (Edgemoor Iron Works).

Dr C E Lucke Retires

Charles E Lucke, Ph D, Sc D, Stevens Professor of Mechanical Engineering, and executive officer of the Dept of Mechanical Engineering, Columbia University, New York, was retired as Emeritus on July 1, 1941, after 39 years of service. His successor as executive officer will be Professor Theodore Baumeister, Jr, who has been a member of the staff for 19 years.

Dr Lucke has devoted half of his time during the academic year and all of the summer vacation period to consulting practice, mainly with corporations, in his specialty of heat and power in nearly all of many engineering applications. He was with the Worthington Pump & Machinery Corp for nine years, and with the Babcock & Wilcox Co for 14 years. He will continue his consulting practice and retain an office at Columbia University.

Charles E Lucke

Professor Baumeister has also maintained industrial connections in parallel with his departmental teaching, and will continue to do so. His specialty is the steam power plant particularly the central station, and its design. He has had association in this capacity with Stevens & Wood, of New York, and is now consultant for the American Gas & Electric Company system.

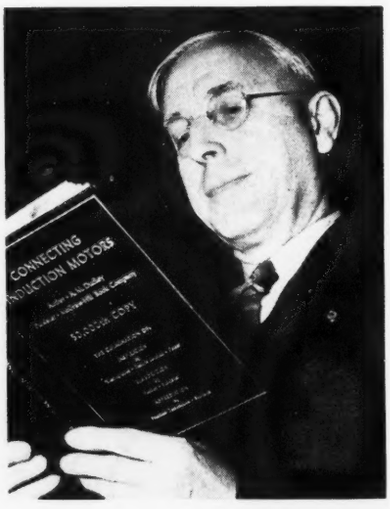
Theodore Baumeister

BOILER RULES AVAILABLE

For some years the ABMA and AI has issued "Suggested Rules for Care and Operation of Power Boilers" in the form of a stiff card suitable for hanging in the boiler room. A revised edition of these rules was presented at the meeting. The ABMA and AI is supplying the card in quantities at cost to manufacturers. It is understood that power engineers can obtain single copies free by addressing A C Baker, secretary, American Boiler Manufacturers Association, 264 Rockefeller Bldg, Cleveland, Ohio.

50,000th Copy

Dr A M Dudley, who, more than 20 years ago, wrote "Connecting Induction Motors", received recently the 50,000th copy of his book from the publisher. Dr Dudley, who lives near Pittsburgh and is engineering repre-



Dr A M Dudley

Cost of replacing a broken-down 4" steel main in a steam distribution system would have cost the Connecticut Light & Power Co. $2344, including new variators, anchors, excavating and road re-surfacing. Unique use of American Metal Hose cut this to $1224 or a saving of $1120.

Underground steam distribution system repaired at saving of $1,120

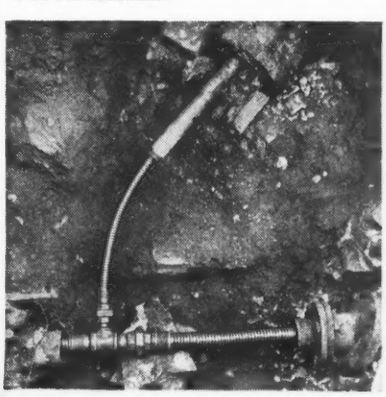
Flexible bronze steam hose and Yankee ingenuity save expense of excavating 364 feet of broken-down steel main

ALTHOUGH American Metal Hose has supplied flexible metal hose and seamless flexible tubing for many curious purposes, Connecticut Light & Power Company's use of steam hose to repair their steam distribution system is one of the most ingenious.

Less spectacular, perhaps, but just as important are thousands of other applications of flexible metal hose and seamless tubing—each serving dependably in the conveyance of air, gas and liquids of all kinds, sometimes under pressure, most times under gruelling conditions.

So, next time you are confronted with a difficult connector problem, investigate American Metal Hose and Seamless Flexible Metal Tubing. Engineers with over 30 years of experience, will help you select the right material. Meanwhile, be sure to read our new booklet, SS-25. Write for your copy. 40238

Excavations were made at four service points. Then 2½" and 2" bronze steam hose was drawn through the existing 4" steel main—less than a half day's work. Sections were connected with brass fittings, tees, nipples and unions. No expansion joints were used in the entire length. When steam was turned on, no lateral expansion was noticeable.



From the tees, sections of 1¼" flexible bronze hose was run through the old 2" services to back of walk and connected to the old service. Says Engineer Gardner of the utility: "Since making this installation, we have used this flexible bronze hose through leaking services under concrete roads with very substantial savings."

American Metal Hose

THE AMERICAN BRASS COMPANY, *General Offices:* Waterbury, Connecticut

In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • *Subsidiary of Anaconda Copper Mining Co.*

ADVERTISING PAGES REMOVED

sentative in the Patent Dept of the Westinghouse Electric & Mfg Co, recalled that he never expected his work to become a handbook for technicians and a textbook for some students.

He began to accumulate material for the volume more than 25 years ago and in 1916 wrote a 12,000-word article for the *Electric Journal*. At the request of F A Annett, associate editor of POWER, Dr Dudley expanded his original article into a series of 15 that appeared intermittently in POWER until 1920.

Dr Dudley has also written correspondence-school courses; another book, "Induction Motor Practice"; a Westinghouse Extension School course, and the article on "Electric Motors" in the current edition of the Encyclopædia Britannica. "Connecting Induction Motors" is published by the McGraw-Hill Book Co, New York, and first appeared in 1921.

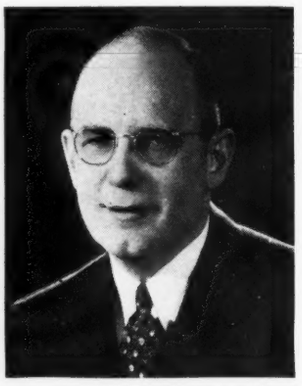
PERSONALS

JAMES H MAGUIRE has retired from active duty as works manager of Haynes Stellite Co, Kokomo, Ind. Mr Maguire will continue with the company in a consulting capacity.

STANLEY F MARR has become mechanical superintendent of Hollingsworth & Vose Co, East Walpole, Mass., following a term of service as assistant to general manager of Parker-Young Co, Lincoln, N. H. In his new post, Mr Marr will have charge of engineering at both the East Walpole and West Groton, Mass., plants of the company.

RALPH D STAUFFER has returned to Cambridge, Mass., as chief engineer for New England Gas & Electric Association, following four years with the E M Gilbert Engrg Corp, Reading, Pa. He is widely known in steam plant circles and in Cambridge will be identified with central station properties.

LEO H HILL, elected vice-president of the Allis-Chalmers Mfg Co May 9, will be the head of newly created Industrial Relations Dept. In his new capacity, Mr. Hill, formerly assistant manager of the electrical department, will be in charge of collective bargaining, grievance procedure, employment, wage policies and levels and all other subjects which bear on management-employee relations.



Leo H Hill

Works manager of Crane Co since 1937, V P RUMLEY has been made vice-president in charge of manufacturing, to succeed J H Collier, recently elected president. Mr Rumley studied mechanical engineering at Purdue University, and later at the University of Wisconsin, from where he was graduated in 1912. In 1914-15 he was with the Buick Motor Co, and in 1916 went with the Hudson Motor Co. Starting in the Hudson Shops, he progressed through many stages of production management to superintendent and factory manager, the position he held until he joined Crane.

V P Rumley

W R SWOISH and JAMES E BEVAN have been appointed vice-president in charge of sales and vice-president in charge of manufacturing operations respectively, of Roller Smith Co, Bethlehem, Pa. Mr Swoish, a graduate of Ohio State University, joined the Roller-Smith organization in 1939 as sales manager. Mr Bevan is a graduate of Lehigh University and entered the employ of the company in 1928, after being associated with Bethlehem Steel Co and Philadelphia Electric Co.

THOMAS W ROLPH has been elected vice-president of the Holophane Co, New York. He first joined the company in 1907, following his graduation from Cornell University. In 1931, when W A Dorey, designing engineer of company retired, Mr Rolph was

(*Continued on page 174*)

Additional Diesel Installations

This list of diesel engines, installed or on order during the period April 1, 1940, to April, 1941, was received too late for inclusion in the tabulation published in POWER for June, page 80.

Owner	Location	Equipt. driven	No. units	Hp each	Rpm	No. cyl	Bore	Stroke
Minkota Power Coop,	Grand Forks, N.D.	Gen	3	1000	300	8	15½	22
Lebanon, Ohio		Gen	2	1000	300	8	15½	22
Tri-Co. Coop,	Portland, Mich	Gen	2	688	400	8	13	16
Clay Co. Coop,	Keystone Hts, Fla	Gen	2	670	400	8	13	16
Fruit-Belt Coop,	Cassopolis, Mich	Gen	3	670	400	8	13	16
Continental Oil Co,	Susank, Kan	Pump	1	560	400	7	13	16
Amtorg Trading Corp,	New York N. Y.	.....	9	470	425	5	13	16
Warner-Hudnut Corp,	New York, N. Y.	Gen	1	450	500	8	10½	13½
Gulf States Utilities,	Jasper, Tex	Gen	1	450	400	6	13	16
Sohio Pipe Line Co,	Hagersville, Ind	Pump	2	450	478	8	10½	13½
Connersville,	Indiana	Gen	1	415	400	5	13	16
Rowan Drilling Co,	Ft. Worth, Tex	Gen	3	375	600	8	9	12
Flint Sand & Gravel Co,	New Orleans	Gen	1	315	515	8	9	12
Greenville Sew Dist,	Greenville, S. C	Gen	1	225	450	4	10½	13½
Calmes Const Co,	New Orleans, La	Gen	1	225	700	6	8	10½
Bayside Dye Works,	Whitestone, L. I	Gen	4	110	327	2	12½	15

These are all Cooper-Bessemer, 4-cycle, air-starting, solid-injection engines.

Additional Gas Engines

This list of gas engines, installed or on order during April 1, 1940, to April 1, 1941, was also received too late.

Owner	Location	Equipt. driven	No. units	Hp each	Rpm	No. cyl	Bore	Stroke
Michigan Gas Trans Co,	Edgerton, Md.	Comp	2*	1300	125	2	21½	36
			3*	1300	125	2	.....	.....
Panhandle E Pipeline Co,	Stinett, Tex.	Comp	1*	1300	125	2	21½	36
Northern Nat Gas Co,	Sublette, Tex.	Comp	3*	1000	125	2	21½	36
			2	150	400	3	9	10½
Claremore,	Oklahoma	Gen	1	880	300	8	15½	22
Big Lake Oil Co,	Texon, Tex	Pump	6	600	400	8	11½	13½
Belridge Oil Co,	Los Angeles, Cal	Gen	5	500	400	8	13	16
Carter Oil Co,	St. Elm, Ill	Gen	1	400	400	8	10½	13½
Midwest Cold Storage,	Kan. City, Kan.	Gen	1	285	600	8	9	10½
Consol Gas & Elec,	Baltimore, Md	Blwr	1	245	690	6	9	10½
Va. Gasoline Corp,	Charleston, W. Va	Gen	1	210	600	6	9	10½
Humble Oil & Ref Co,	Wink, Tex	Gen	1	200	400	4	11½	13½
West Products Co,	Houston, Tex	Gen	1	187	400	8	9	10½
Pure Oil Co,	Noble, Ill	.....	2*	155	300	2	12½	15
Pure Oil Co,	Olney, Ill	.....	2*	150	250	2	12½	15
Potapsco Sewage Works,	Baltimore, Md.	Gen	1†	120	514	4	9	10½
Tidewater Assoc Oil Co,	Cyclone, Pa	Pump	3*	65	250	1	13½	16

These are all Cooper-Bessemer, vertical 4-cycle engines, except those marked (*), which are horizontal, 2-cycle units. All burn natural gas except the one marked (†), which burns sewage gas.

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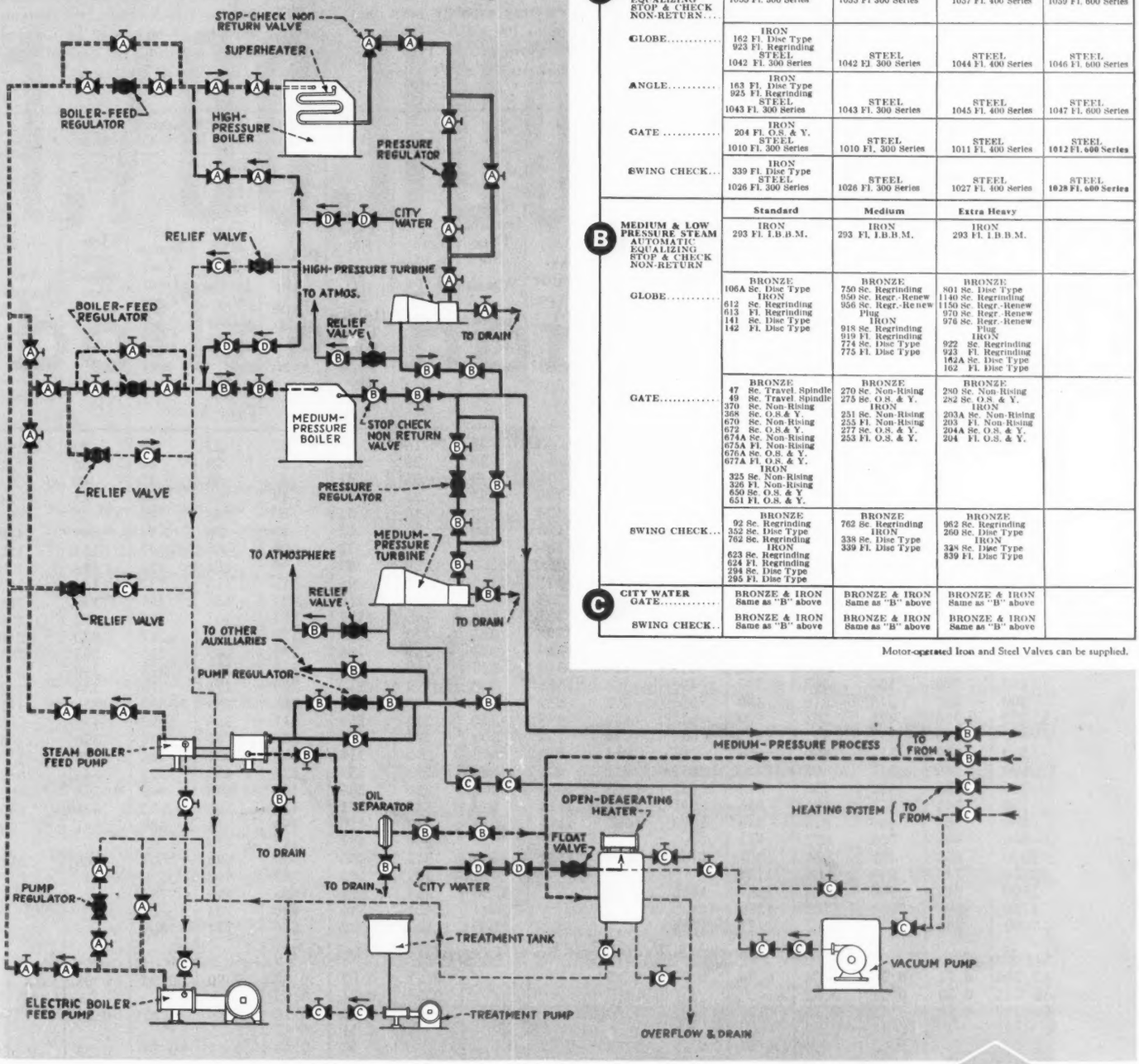
FOR H. P. STEAM SERVICES . . .

Jenkins RECOMMENDS . . .

INDUSTRIAL "TOPPING" PLANT



REFERENCE CHART FOR JENKINS FIGURE NUMBERS

		Up to 250 lbs.	Up to 300 lbs.	Up to 400 lbs.	Up to 600 lbs.
A	HIGH PRESSURE STEAM AUTOMATIC EQUALIZING STOP & CHECK NON-RETURN				
	GLOBE	IRON 162 Fl. Disc Type 923 Fl. Regrinding STEEL 1042 Fl. 300 Series	STEEL 1042 Fl. 300 Series	STEEL 1044 Fl. 400 Series	STEEL 1046 Fl. 600 Series
	ANGLE	IRON 163 Fl. Disc Type 925 Fl. Regrinding STEEL 1043 Fl. 300 Series	STEEL 1043 Fl. 300 Series	STEEL 1045 Fl. 400 Series	STEEL 1047 Fl. 600 Series
	GATE	IRON 204 Fl. O.S. & Y. STEEL 1010 Fl. 300 Series	STEEL 1010 Fl. 300 Series	STEEL 1011 Fl. 400 Series	STEEL 1012 Fl. 600 Series
	SWING CHECK	IRON 339 Fl. Disc Type STEEL 1026 Fl. 300 Series	STEEL 1026 Fl. 300 Series	STEEL 1027 Fl. 400 Series	STEEL 1028 Fl. 600 Series
		Standard	Medium	Extra Heavy	
B	MEDIUM & LOW PRESSURE STEAM AUTOMATIC EQUALIZING STOP & CHECK NON-RETURN	IRON 293 Fl. I.B.B.M.	IRON 293 Fl. I.B.B.M.	IRON 293 Fl. I.B.B.M.	
	GLOBE	BRONZE 106A Sc. Disc Type IRON 612 Sc. Regrinding 613 Fl. Regrinding 141 Sc. Disc Type 142 Fl. Disc Type	BRONZE 750 Sc. Regrinding 950 Sc. Regr.-Renew 956 Sc. Regr.-Renew Plug IRON 918 Sc. Regrinding 919 Fl. Regrinding 774 Sc. Disc Type 775 Fl. Disc Type	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Renew 970 Sc. Regr.-Renew 976 Sc. Regr.-Renew Plug IRON 922 Sc. Regrinding 923 Fl. Regrinding 162A Sc. Disc Type 162 Fl. Disc Type	
	GATE	BRONZE 47 Sc. Travel. Spindle 49 Sc. Travel. Spindle 370 Sc. Non-Rising 368 Sc. O.S.& Y. 670 Sc. Non-Rising 672 Sc. O.S.& Y. 674A Sc. Non-Rising 675A Fl. Non-Rising 676A Sc. O.S. & Y. 677A Fl. O.S. & Y. IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S. & Y. 651 Fl. O.S. & Y.	BRONZE 270 Sc. Non-Rising 275 Sc. O.S. & Y. IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	BRONZE 280 Sc. Non-Rising 282 Sc. O.S. & Y. IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.	
	SWING CHECK	BRONZE 92 Sc. Regrinding 352 Sc. Disc Type 762 Sc. Regrinding IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type	BRONZE 962 Sc. Regrinding 260 Sc. Disc Type IRON 348 Sc. Disc Type 839 Fl. Disc Type	
C	CITY WATER GATE	BRONZE & IRON Same as "B" above	BRONZE & IRON Same as "B" above	BRONZE & IRON Same as "B" above	
	SWING CHECK	BRONZE & IRON Same as "B" above	BRONZE & IRON Same as "B" above	BRONZE & IRON Same as "B" above	

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Number 108

Current-Carrying Capacity of Conductors in Amps Allowed by the National Electrical Code

▶ For definitions of the conductor type letters, see article on page 94 and table on page 95.

The first 9 columns of the table, counting from the left, give current-carrying capacities of single-conductors installed in free air at a temperature not exceeding 86 F. Concealed knob and tube work is included in this classification. The 7 right-hand columns list current-carrying capacities of conductors, when there are not more than three in a conduit or other type of raceway and air temperature doesn't exceed 86 F.

For room temperatures higher than 86 F. the carrying capacity of the conductors must be corrected according to the factors given below each column. For example, with not more than three No. 0000 "Rubber Type RW or R" conductors in a conduit, their allowable carrying capacity is 160 amp, where room temperature does not exceed 86 F. If room temperature is 113 F then allowable carrying capacity must be reduced by 0.5 or to $160 \times 0.5 = 80$ amp. For temperatures above 113 F, Type RW and R rubber insulations aren't allowed.

Bare conductors have the same allowable carrying capacity as the insulated conductors with which they are used. Aluminum conductors have a current-carrying capacity equal to 84% of corresponding copper conductors.

When 4 to 6 conductors are installed in conduit or other type of raceway, current-carrying capacity of each must be reduced to 80%, and for 7 to 9 conductors current-carrying capacity of each must be reduced to 70% of that permitted for each of three conductors installed in a raceway.

	Single Conductor in Free Air; Room Temp 86 F								Not More Than Three Conductors in Raceway or Cable; Room Temp 86 F						
Size AWG or MCM	Rubber Type R	Rubber Type RP	Rubber Type RHT Type RH	Synthetic Type SNA Asbestos Var-Cam Type AVB Var-Cam Type V	Asbestos Var-Cam Type AVA	Impregnated Asbestos Type AI	Asbestos Type A	Slow-burning Type SB Weather-proof Type W Type SBW	Rubber Type RW Type R	Synthetic Type SN Type RU Rubber Type RPT Type RP	Rubber Type RHT Type RH	Paper Synthetic Type SNA Asbestos Var-Cam Type AVB Var-Cam Type V	Asbestos Var-Cam Type AVA Type AVL	Impregnated Asbestos Type AI	Asbestos Type A
14	20	24	29	30	39	40	43	23	15	18	22	23	28	29	32
12	26	31	37	40	51	52	57	30	20	23	27	29	36	38	42
10	35	42	50	54	65	69	75	40	25	31	37	38	47	49	54
8	48	58	69	71	85	91	100	53	35	41	49	50	60	63	71
6	65	78	91	99	119	126	134	70	45	54	65	68	80	85	95
5	76	92	110	115	136	145	158	80	52	63	75	78	94	99	110
4	87	105	125	133	158	169	180	90	60	72	86	88	107	114	122
3	101	122	146	155	182	194	211	100	69	83	99	104	121	131	145
2	118	142	170	179	211	226	241	125	80	96	115	118	137	147	163
1	136	164	196	211	247	264	280	150	91	110	131	138	161	172	188
0	160	193	230	245	287	306	325	200	105	127	151	157	190	202	223
00	185	223	267	284	331	354	372	225	120	145	173	184	217	230	249
000	215	259	310	330	384	410	429	275	138	166	199	209	243	265	284
0000	248	298	358	383	446	476	510	325	160	193	230	237	275	308	340
250	280	338	403	427	495	528	562	350	177	213	255	272	315	331	372
300	310	373	446	480	555	592	632	400	198	238	285	299	347	380	415
350	350	421	501	529	612	653	698	450	216	260	311	325	392	419	462
400	380	457	547	575	665	710	755	500	233	281	336	361	418	450	488
500	430	517	620	660	765	814	870	600	265	319	382	404	468	498	554
600	480	577	691	738	857	912	970	680	293	353	422	453	525	543	612
700	525	632	756	813	942	1003	1065	760	320	385	461	488	562	598	668
750	545	655	785	846	981	1044	1118	800	330	398	475	502	582	621	690
800	565	680	815	879	1020	1085	1150	840	340	410	490	514	600	641	720
900	605	728	872	941	.....	.....	.....	920	360	434	519	556	.....	.....	.....
1000	650	782	936	1001	1163	1238	1332	1000	377	455	543	583	681	730	811
1250	740	890	1066	1131	.....	.....	.....	.....	409	493	589	643	.....	.....	.....
1500	815	980	1174	1261	1452	.....	.....	1360	434	522	625	698	784	.....	.....
1750	890	1070	1282	1370	.....	.....	.....	.....	451	511	650	733	.....	.....	.....
2000	960	1155	1383	1472	1713	.....	.....	1670	463	558	666	774	839	.....	.....
C F	Correction Factor for Room Temperatures Over 86 F														
40 104	0.71	0.82	0.88	0.90	0.94	0.95	.....	.....	0.71	0.82	0.88	0.90	0.94	0.95	.....
45 113	0.50	0.71	0.82	.....	.....	.....	.....	.....	0.50	0.71	0.82	.....	.....	.....	.....
50 122	0.00	0.58	0.75	0.80	0.87	0.89	.....	.....	0.00	0.58	0.75	0.80	0.87	0.89	.....
55 131	.....	0.41	0.67	.....	.....	.....	.....	.....	.....	0.41	0.67	.....	.....	.....	.....
60 140	.....	0.00	0.58	0.67	0.79	0.83	0.97	.....	.....	0.00	0.58	0.67	0.79	0.83	0.97
70 158	.....	.....	0.35	0.52	0.71	0.76	0.93	.....	.....	.....	0.35	0.52	0.71	0.76	0.93
75 167	.....	.....	0.00	.....	.....	.....	.....	.....	.....	.....	0.00	.....	.....	.....	.....
80 176	.....	.....	.....	0.30	0.61	0.69	0.89	.....	.....	.....	.....	0.30	0.61	0.69	0.89
90 194	.....	.....	.....	.....	0.50	0.61	0.86	.....	.....	.....	.....	.....	0.50	0.61	0.86
100 212	.....	.....	.....	.....	.....	0.51	0.82	.....	.....	.....	.....	.....	.....	0.51	0.82
120 248	.....	.....	.....	.....	.....	.....	0.72	.....	.....	.....	.....	.....	.....	.....	0.72
140 284	.....	.....	.....	.....	.....	.....	0.63	.....	.....	.....	.....	.....	.....	.....	0.63

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Ordered for more than

1,700,000

boiler horsepower

No other steam-flow type feed water regulator has ever been accepted so widely, so quickly. You will find installations of the COPES Flowmatic Regulator now in service or on order:

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In 34 states and in 11 other countries—on 4 of the 5 continents.

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On B. & W., Badenhausen, Bigelow, C-E, Edge Moor, Erie City, Foster Wheeler, Freyn, Riley, Springfield, Union, Vogt, Wickes and 10 other makes of boilers.

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On boilers operating at pressures of from 80 to 1900 pounds gage.

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On boilers having capacities from 15,000 to 550,000 lbs. per hour.

To be specific . . . in a little less than four years, the COPES Flowmatic Regulator has been ordered for 380 boilers with a total steaming capacity of 58,667,050 pounds per hour. And for good reason. The COPES Flowmatic gives remarkably close water level control . . . usually within plus-or-minus one inch . . . regardless of boiler design, pressure or load conditions. Yet the design is so mechanically simple, the construction so rugged, that no more than routine servicing is needed. For complete information on this two-element steam-flow type regulator, write for Bulletin 429.

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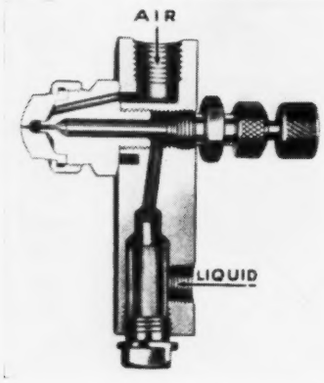
WHAT'S NEW IN PLANT EQUIPMENT

Atomizing Nozzle

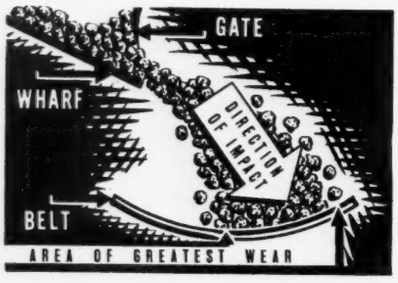
ILLUSTRATION shows pneumatic atomizing nozzle especially applicable to chemical and industrial processes, and humidifying. Nozzle available with internally mixed



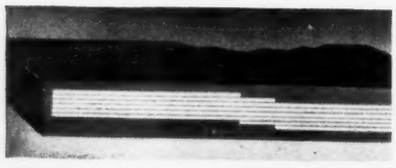
round or flat spray, with fluid shut-off needle optional. Air connection is ¼ in., while fluid connection is ⅛-in. pipe thread. Strainer is removable. *Spraying Systems Co, 4021 W Lake St, Chicago, Ill.*

Conveyor Belt

TURNABLE CONVEYOR BELT PROVIDES double thickness of cover over areas of greatest wear, on each side of belt, so that when abrasion wears down one side, belt can be



turned over and additional service obtained from untouched cover areas. Four full-width and four half-width plies of 32-oz duck provide total tensile strength equal to six full-width plies. Cover thickness of



greatest wear-area on top and bottom of belt is ¼ in., and ⅛ in. over remaining width. When quenching is not thorough and burning material (coke) hits belt, cover thickness greater than ¼-in. is recommended. Belt, in addition to coke wharf duty, is also adaptable to any service where off-center loading causes premature belt-failure. *B F Goodrich Co, 460 S Main St, Akron, Ohio.*

Waterproofing Compound

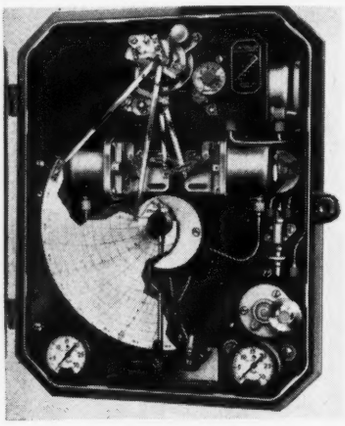
HYDROZO IS LIQUID-TYPE waterproofing compound for masonry. Consists of colorless synthetic mineral gum reduced with a volatile to form liquid compound. Maker claims compound can be applied to finest types of masonry without changing its appearance and will penetrate pores of masonry to a depth of from one to three-fourths of an inch. *Hydrozo Products Co, 2725 Kendall Ave, Madison, Wis.*

Insulating Fire Brick

NEW LINE ANNOUNCED FOR TEMPERATURE RANGE from 1600 to 2600 F, for direct exposure in wide variety of furnaces, and other heated equipment, except where subjected to slag action or mechanical abuse. New brick is produced from plastic refractory clay and organic filler which, upon being burnt out during manufacturing process, gives uniform controlled pore-structure to each of various types. Brick are furnished in four temperature limits: JM-16 for exposed service to 1600 F, and for back-up service to 2000 F; JM-20 and 26 for exposed or back-up temperatures to 2000, 2300 and 2600 F, respectively. *Johns-Manville, 22 East 40th St, New York, N. Y.*

Ratio Controller

CONTROLLER IS FOR USE WHERE TEMPERATURE, pressure, rate-of-flow or liquid level must be controlled in desired ratio or differential to another related variable. Controller has two measuring systems: one, adjusting system which indicates or records only; and other, controlling system, which may either indicate or record. Adjusting system resets control point of controlling system through a linkage arrangement according to predetermined ratio. Ratio can be changed by simple screwdriver adjustment directly on cali-

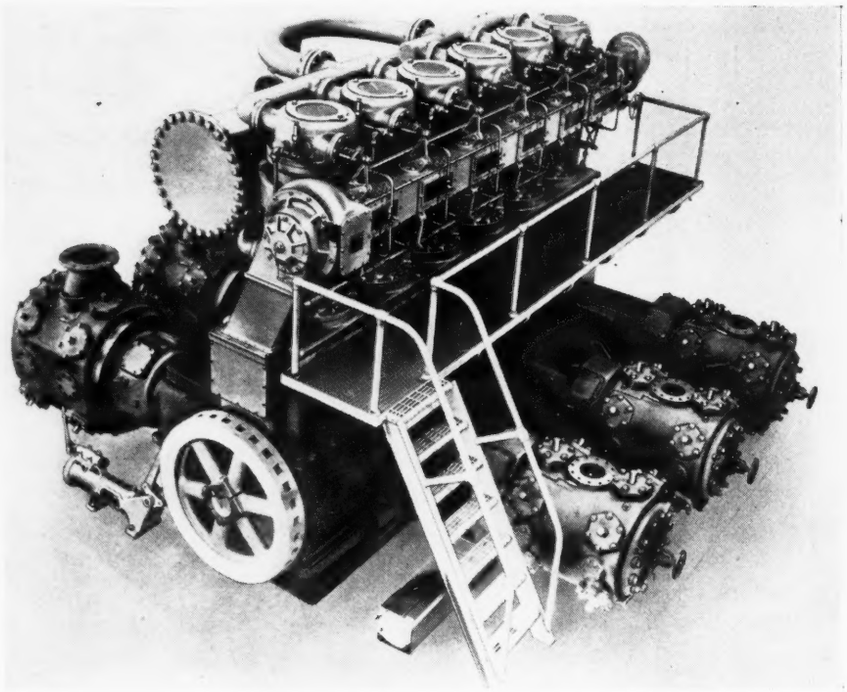


brated dial throughout range of 0:1 to 3:1 direct or inverse. With new instrument, it is unnecessary to disturb processing or remove chart while making adjustments. *Taylor Instrument Cos, Rochester, N. Y.*

Steam-Driven Compressor

CLARK COMPRESSORS ARE FOR industrial, chemical and petroleum use, and are furnished in capacities from 600 to 4000 hp. Machines have three to six power cylinders and corresponding number of compressor cylinders. Construction is based on right-angle design of company's gas-engine-

(*Continued on page* 150)



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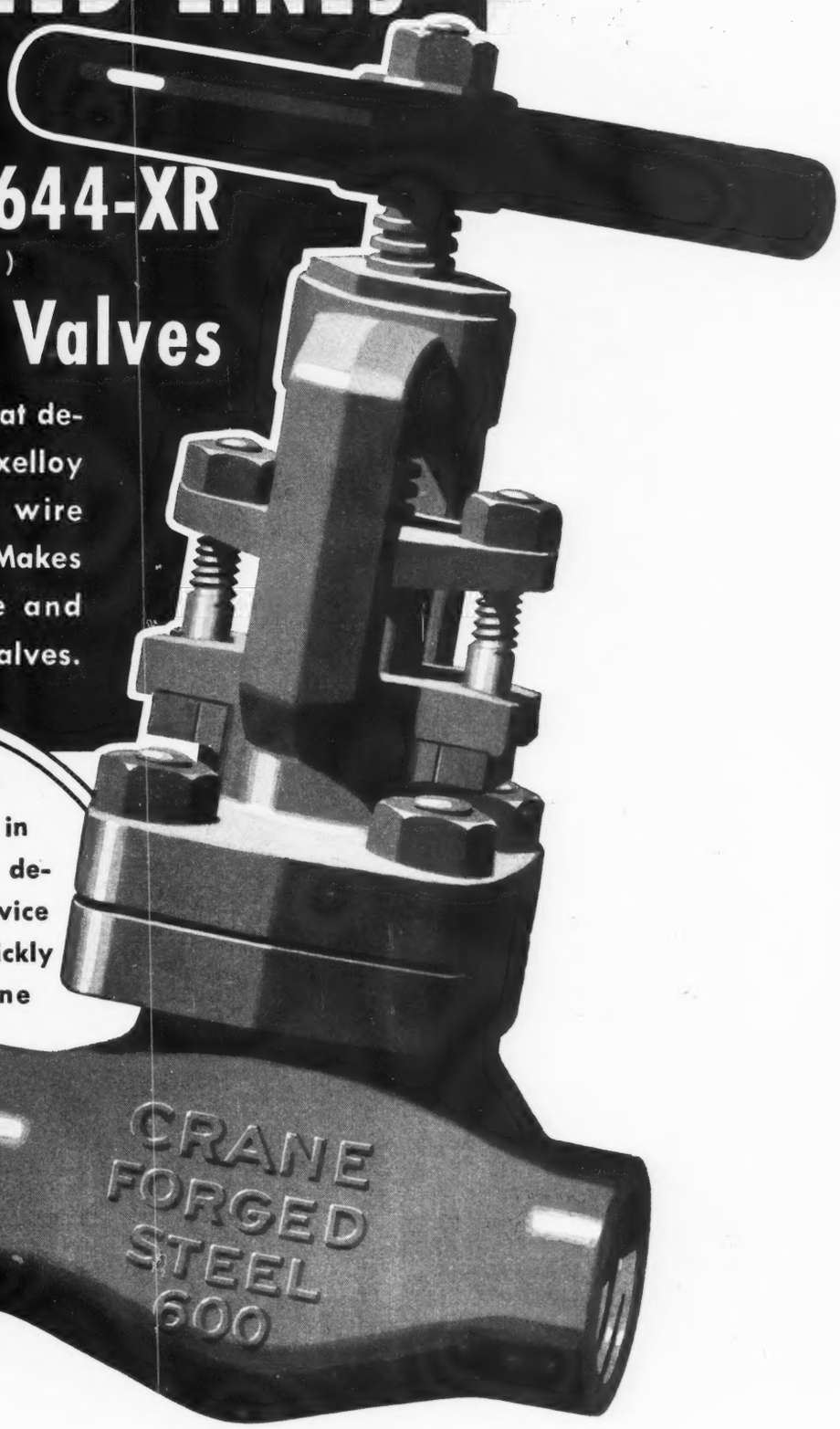
Crane plug type disc and seat design of Nickel Alloy and Exelloy minimizes damage from wire drawing and foreign matter. Makes long-lasting tight closure and extends service life of valves.



. . . One of 38,000 valves and fittings in the Crane line—each designed to give finest service in a specific need—and quickly available through Crane branches and wholesalers everywhere.

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CRANE CO., 836 SOUTH MICHIGAN AVENUE, CHICAGO

New Transformer for Base Loads

New magnetic steel makes possible 40,000-kva units that can be shipped complete with oil sealed into transformer tanks, ready for immediate service

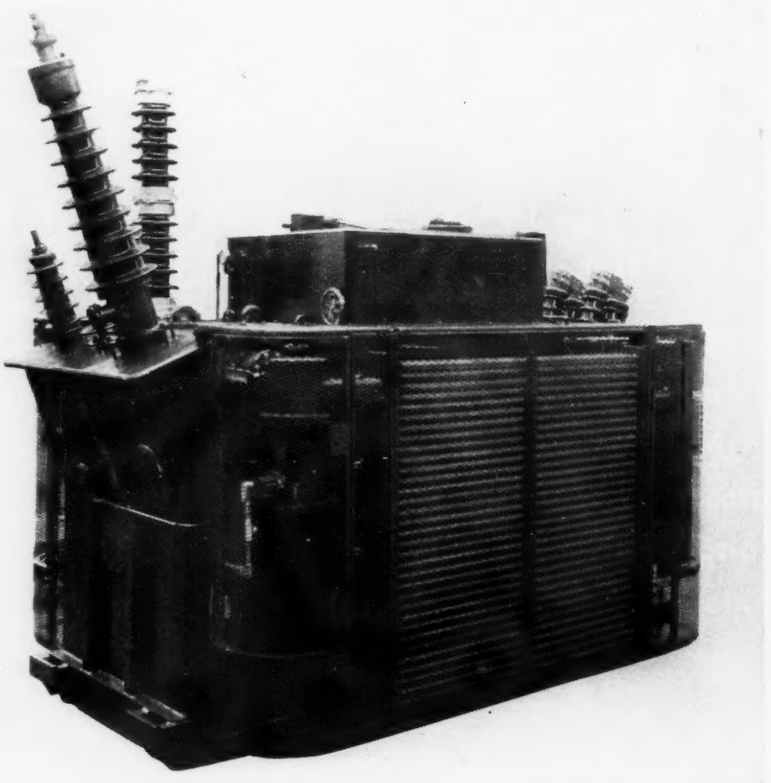
► AT THE SUMMER CONVENTION of the American Institute of Electrical Engineers, Philip Sporn, chief engineer, American Gas & Electric Service Corp, and H V Putnam, manager, transformer division, Westinghouse Electric & Manufacturing Co, described the application of Hipersil, a new transformer-core steel, to three 40,000-kva, 138-kv transformers for the Philo Generating station of the Ohio Power Co. An outstanding characteristic of this new steel is that it will carry approximately one-third more magnetic flux than standard silicon-steel transformer cores of comparable size.

Forced-air and forced-oil cooling are incorporated in the design of these transformers. As a result of these features, in combination with the new magnetic steel, copper in the transformers weighs 10% less and the magnetic iron 25% less than standard self-cooled, air-blast units of the same rating. Because of their small size, these transformers will be completely assembled in the factory and shipped with bushings in place ready to go onto their foundations. Tank covers are welded on without any provision for breathing, and the units are permanently sealed against deterioration of oil and insulation.

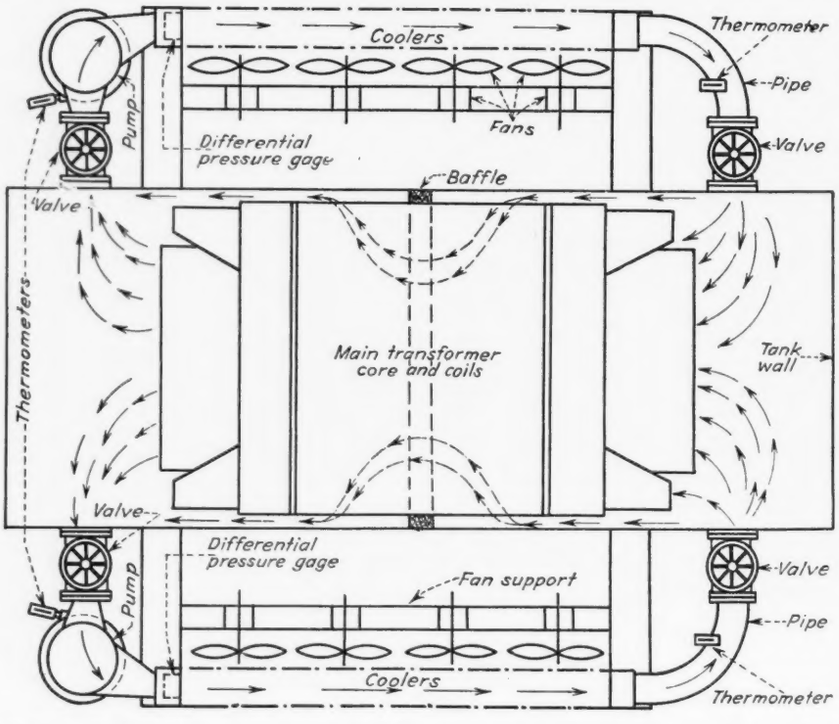
These shell-type transformers are mounted horizontally in their tanks. Fin-type coolers employing round tubes of substantial cross-section are mounted on each side of the tank walls and provided with circulating pumps and cooling fans. The two radiator assemblies on each transformer are operated as independent units. Power for pumps and fans is supplied from two auxiliary transformers mounted inside the main unit, one auxiliary transformer taking care of one radiator bank. Each auxiliary transformer, however, has sufficient capacity to supply power for pumps and fans of both cooling units. If one auxiliary transformer fails its fans and pumps can be immediately connected to the other transformer.

Both oil-circulating pumps operate at no load, but fans come on automatically according to rise in oil temperature. Differential pressure relays are provided on each circulating pump. With only one pump in operation, capacity of the

(*Continued on page 138*)



This 40,000-kva, 138 kv transformer is completely sealed with cover welded into place



Forced-oil-circulation pumps and air-blast fans are arranged in two independent assemblies with the oil coolers; each assembly is supplied with power from a separate auxiliary transformer mounted inside main tank

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ENGINEERS' BOOKSHELF

Getting a Job

How You Can Get a Better Job 1941). *By Willard K Lasher, Student Counselor, and Edward A Richards, formerly Associate Director of University Extension, Columbia University. Published by American Technical Society, Drexel Ave & 58th St, Chicago, Ill. 175 pages, 5½x8 in.; illustrated; cloth binding. Price $1.50.*

Here is a book everyone should read for both pleasure and profit. The foreword states that it has been written for men and women seeking employment, or for those determined to leave the jobs they have, not by quitting, but by earning a promotion. The book is all this—written in a pleasant, instructive and sympathetic style, and filled with practical down-to-earth ideas the two authors have used and developed during their many years on the hiring line.

Both have worked with many men and women from all sections of the country. The wealth of their combined experiences is boiled down in this book into crystal clear explanation and narratives of the vital steps everyone must take to get work or earn promotion.

Mathematics

Practical Mathematics (Second Edition, 1941). *By Glenn M Hobbs and James McKinney. Revised by J Ralph Dalzell, head of Mathematics Department, American School. Published by American Technical Society, Drexel Ave & 58th St, Chicago, Ill. 599 pages, 5½x8 in., illustrated, tables, cloth binding. Price $2.40.*

People in all walks of life forget the mathematics they learned in school and then find themselves in a position where they need this knowledge. This book has been written for beginners, for those who have forgotten and want to review, and for use in vocational schools. The new edition of this popular book incorporates much of the experience gained in the use of the first edition, and has 145 more pages.

Principles of arithemetic, simple equations and formulas, mensuration, graphs and logarithms are presented in a simple step-by-step method that anyone can understand. At the end of each section is a final examination, with the correct answers in the back, making it well suited for home study.

Mechanisms

Mechanism (1941). *By Stanton E Winston, Associate Professor of Mechanical Engineering, Illinois Institute of Technology. Published by American Technical Society, Drexel Ave & 58th St, Chicago, Ill. 372 pages, 5½x8 in., 199 illustrations, cloth binding. Price $3.50.*

Many operating and other engineers daily contact mechanisms of whose fundamental principles they are unaware. This book was written as a companion text to one on machine design, but those who would have a better understanding of the mechanisms that they are responsible for will find in it a wealth of information presented in simple terms.

Starting with such mechanisms as found in steam engines, the treatment follows through linkages, belt drives, chains, gears, trains of mechanisms and cams. The basic principles of the three ordinary modes of transmission of motion are developed and a limited number of types of transmissions of each mode are studied. In analyzing the relative motion of the elements of these mechanisms the graphical method rather than the algebraic is stressed. The text contains many illustrative examples and is presented to help the student develop an ability to analyze and visualize kinematic problems.

Electrical Wiring

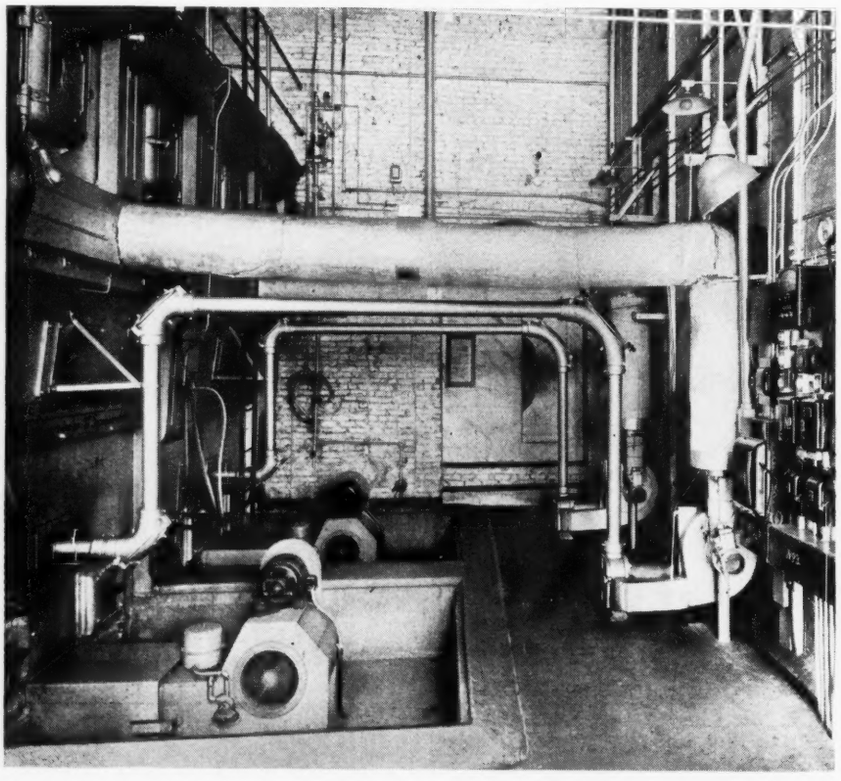
Practical Electrical Wiring (Second Edition, 1941). *By H P Richter. Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York, N. Y. 521 pages, 5½x8 in., 451 illustrations, 40 tables, cloth binding. Price $3.00.*

The National Electrical Code is the minimum standard of electric wiring for light and power. The 1940 edition of this code contains many radical changes from previous editions, which is one of the chief reasons for the second edition of this book.

Everything in the first edition has

(*Continued on page 142*)

GAS COAL CONVEYOR



Coal rides to the fires on blasts of hot gas in this installation at Wayne Iron Works, Richmond, Ind. Steel worms in Iron Fireman stokers in front of wall feed coal from bin to hot gas stream drawn from fireboxes by forced-draft fans. This hot gas stream carries coal up and over through the tubes to the fire

ANY SHAPE...ANY SIZE

PIPING ASSEMBLIES for meeting the most complex and highly specialized pressure and temperature requirements of Central Stations, Industrial and Process Plants are fabricated in the KELLOGG shops.

Accurately prefabricated, thoroughly tested, they are shipped ready to connect, saving time and money on the job.

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Mother O'Leary's Cow . . .

One dark night, when we were all in bed,
Old Mother O'Leary left the lantern in the shed,
And when the cow kicked it over, she winked her eye and said:
"There'll be a hot time in the old town tonight!"

ALMOST EVERYBODY remembers that old song, but Chicagoans have a particular reason for remembering. Historians insist that Mrs O'Leary didn't intend to set the great Chicago fire—she just left the lantern on the straw too close to the cow. But Chicago burned down just as completely as if she'd done it intentionally.

Modern Jersey City fights a $25,000,000 fire. Authorities insist there is no evidence of sabotage—the cause was probably a carelessly thrown cigarette. But twenty-five million dollars still went up in smoke. Even worse, it was smoke of finished products—with every possible man-hour already packed in. The money loss is readily replaced, but right now we as a nation can't afford to spare the skilled time it represents.

Philadelphia has a million-dollar lumberyard fire. Again no evidence of sabotage, but the lumber is gone and other industries seriously threatened — and that million dollars worth of lumber had been guarded by just one man! There is carelessness again. Carelessness has little enough excuse at any time, but in the midst of this emergency, it is closest of kin to sabotage.

I speak of this because I know of dozens of power plants which are courting fire. Inflammable waste thrown carelessly into corners, gasoline and oil and paint in cans perilously near heat or even open flame, uninsulated electric wire—dozens of other fire hazards exist all around us. They've been dangerous all along, but now they're traitorous too, for every fire burns up materials of which we already have far too little.

The situation will be worse before it gets better, also. Increasing production is going to mean steadily increasing concentrations of finished and waste products, steadily increasing opportunities for fire, explosion, soaking, or any of the dozens of other destructive things that can occur when the wrong materials get together. And stepped-up production speed itself is an incentive to carelessness.

Remember now that old saying, "For want of a nail the kingdom was lost," and don't provide the materials for sabotage or carelessness to convert into irreplaceable loss. Remember—all fires are little, *at first*. Keep dangerous materials in isolated and protected spots, provide adequate supervision, and make certain that in case trouble does start, the necessary protection is available. Only when you've done all three of these, in addition to guarding your plant from *outside* dangers, have you done all you can to protect against intentional—and *unintentional*—sabotage.

George Edwards
Engineer

J-M Moulded Packing Cups are made to take the toughest kind of service on all types of slow-moving pistons and rams operating against air, water, steam, oil, etc. Even against extremely high pressures and temperatures they stand up in service and assure a positive seal with minimum friction.

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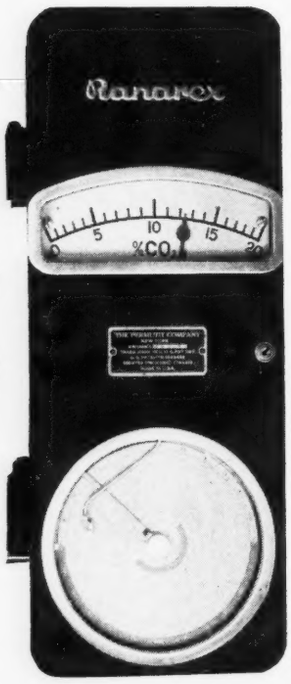

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Conductor Insulation

(*Continued from page 96*)

able only as leads to equipment, not for general raceway installations. Limit on maximum operating voltage is 300 volts. Type-A designation covers several different types of construction and probably should be broken down into several designations in order to line up with manufacturers' and Code practice for other types of wires and cables.

Impregnated asbestos-insulated wire, Type AI (Fig. 16), consists of a copper conductor and asbestos insulation impregnated with a moisture-resistant compound. It may or may not have an asbestos braid in addition; voltage limitation is changed accordingly. Without the additional impregnated braid, Type AI is limited to 300 volts, with the braid the limit is 600 volts. Maximum operating temperature is 125 C (257 F) due to limitations of the impregnating material.

Paper-insulated cable (Fig. 17), used more in public utility work rather than for installations coming within the jurisdiction of the National Electrical Code, is nevertheless recognized for service-entrance use. When so recognized its maximum operating temperature is 85 C (185 F). Very little of it is used for this purpose, and then generally only where the cable is an extension of an underground system.

Slow-burning wire, Type SB (Fig. 18), one of the oldest types recognized by the Code, has been used for the most part on insulators in mill-type buildings. This wire consists of a copper conductor and three braids impregnated with a fire-retardant material similar to paint, has a maximum operating temperature of 90 C (194 F) and is for use only in dry locations where the temperature is such that rubber or varnished-cambric insulation is not suitable. There is some question as to whether the intention is to prohibit its use on insulators in mill-type buildings at lower temperatures, but there is no doubt that it is not intended for use in conduit at the lower temperatures where condensation of moisture might be a factor.

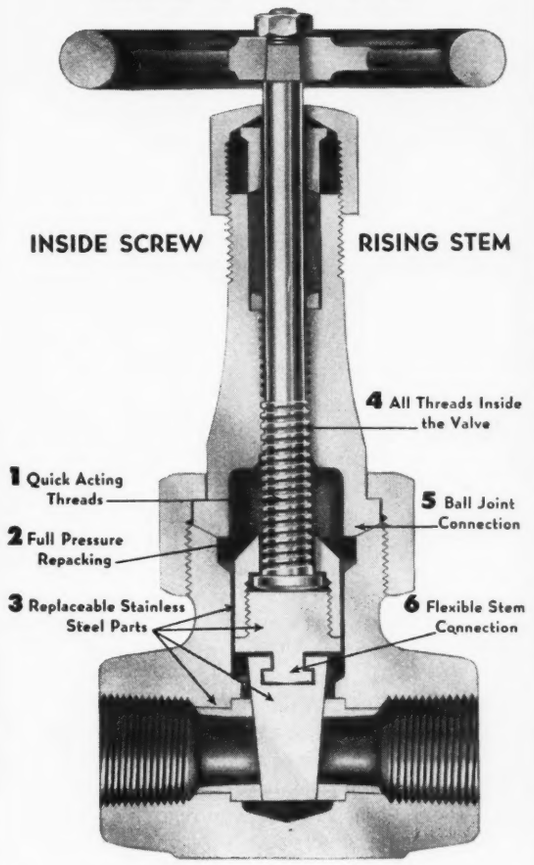
Slow-burning weatherproof wire, Type SBW (Fig. 19), is very similar to slow-burning wire, except that the inner braid is treated with a moisture-resistant compound. It has the same limitations as Type SB.

Weatherproof wire, Type WP (Fig. 20), is a very special product in so far as installation inside buildings is concerned. The chief use is for outside

6 "Trouble-Shooting" Features

in this Forged-Steel Gate Valve

CHAPMAN LIST 960



COMPARATIVE OPERATING TESTS . . . on any line from ¼" to 2" . . . will prove that Chapman's 960 far outlasts any similar type of valve . . . that it saves on repairs and replacements . . . that it replaces customary small-valve troubles with dependable, grief-proof performance. *All because of the 6 exclusive Chapman features above.* Good for pressures up to 800 lb. at 750°, or 1500 lb. cold working pressure. Test for yourself . . . and see why it pays to standardize on List 960. WRITE.

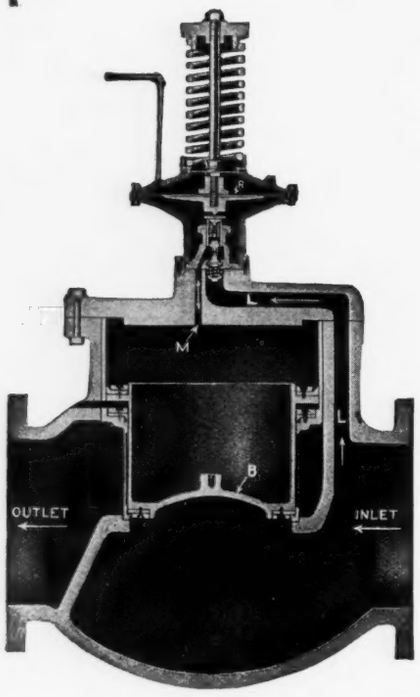
The

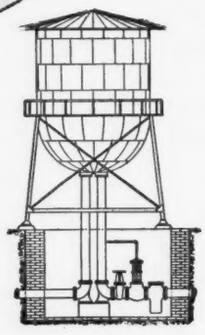
CHAPMAN VALVE

MANUFACTURING COMPANY

Indian Orchard, Massachusetts

Golden Anderson
SPECIALTY
VALVES





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• Hold efficiency at an even level by equipping your tank or standpipe with G-A Altitude control valves. You'll get a constant, automatic water level at all times, with no overflow. This valve is positive in action, with no water or hammer shock. Comes in sizes of 2" to 36", in either globe or angle pattern. Air and water cushioned, it also includes full bronze trim with no metal contacts. Write for your free copy of the G-A catalog . . . it completely describes the entire line.

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FULTON BLDG. PITTSBURGH, PA.

duty on poles and insulators. Temperature limit on Type WP is 80 C (176 F); a copper conductor and three cotton braids or the equivalent are impregnated with a moisture-resistant compound.

For further information in the use of these wires the reader is referred to the table on page 126 and to the National Electrical Code, copies of which can be obtained from the National Board of Fire Underwriters, 85 John St, New York, N. Y.

New Transformer

(*Continued from page* 130)

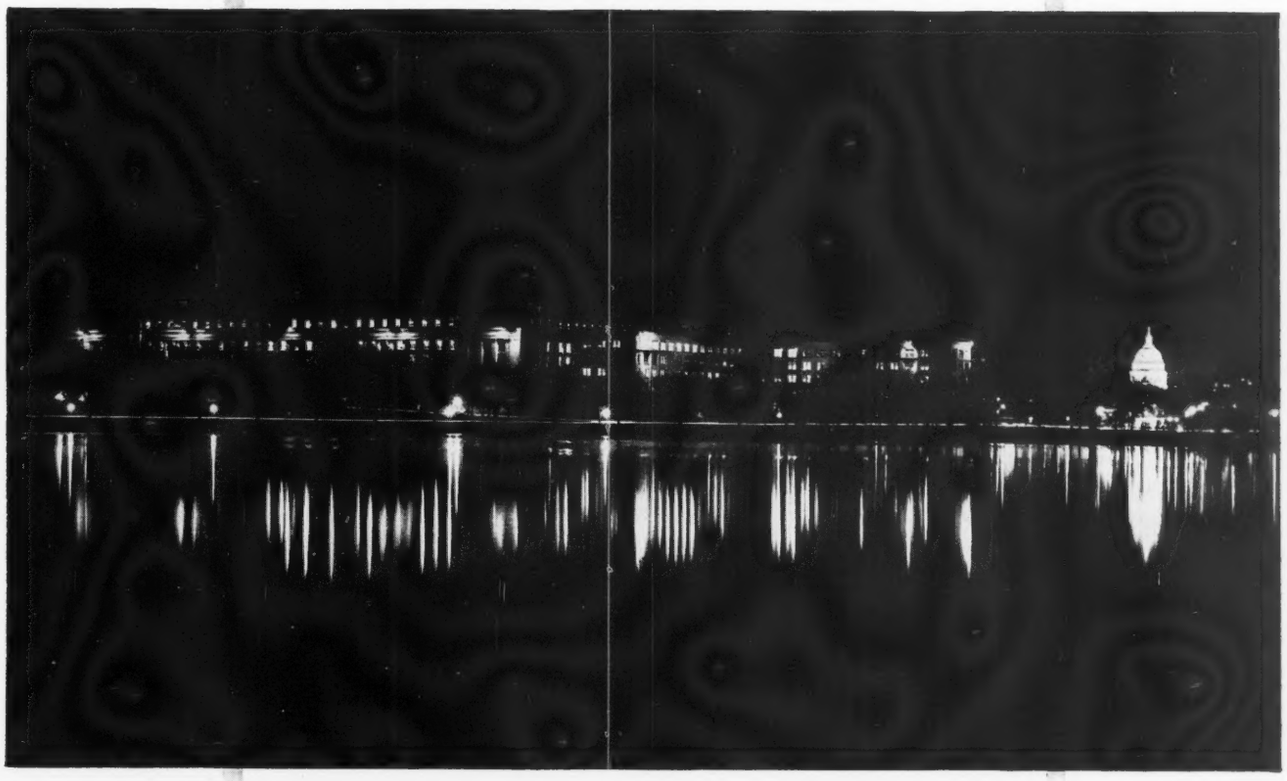
transformer is reduced to 80%. If oil flow through one of the coolers stops, the differential pressure relay sounds a warning to the station operator. If both pumps stop, a signal is given to clear the units from the line.

Relays on each unit operate on copper temperature. At 105 C (221 F) copper temperature, a warning signal is sounded to the station operator indicating that load should be reduced. If copper temperature continues to increase and reaches a dangerous point, a relay signals the station operator for immediate shutdown.

Sixteen simple air-blast fans driven by motors with sealed-for-life bearings are employed on each cooler. A vertical motor-driven oil-circulator pump on each cooler is completely sealed and mounted in the oil circulation system so that both stator and rotor windings are submerged and bearings continually lubricated at all times by transformer oil.

The conclusions reached were that development of Hypersil has opened up many new avenues for design of transformers. Coupled with other design ideas, it has made possible more economical production of large units through reduction in size and amount of material required. Using standard magnetic steel, large transformers have had to be shipped in nitrogen gas in special containers to get by bridge and tunnel clearances. Upon arrival they required a considerable amount of erection work and expense prior to being placed into service. The use of Hypersil automatically extends the rating size before this becomes necessary. The same development will make possible extending the practical size of portable transformers whether on car or trailer. Finally, the authors believe this development is but another proof of the vitality of the electric-power art, and of the ability of modern technology to move rapidly forward even in a well-developed field.

★ COAL ★



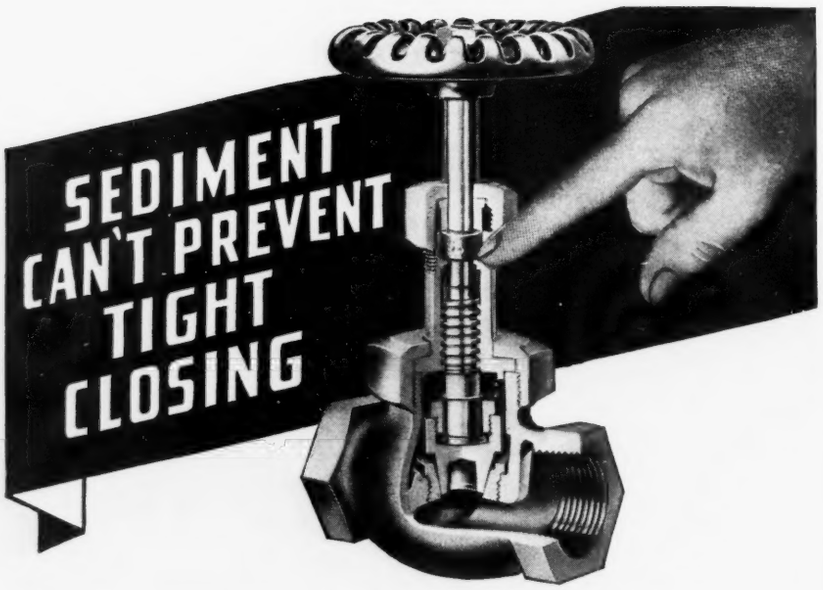
. . . on the first line of NATIONAL DEFENSE!

ONE of the countless posts at which dependable, modern COAL is on duty to furnish power and light for America's needs is at the Nation's Capital. Continuous power for Washington is provided by the Buzzard Point and Benning plants of the Potomac Electric Power Company. Busy Washington makes tremendous demands on power service, but these two plants can put 305,000 kilowatts of energy on the wires. This ready power supply, says Mr. H. G. Thielscher, Engineer of Potomac Electric, is "produced by burning coal—a fair compliment to the *dependability and economy of COAL*—where continuity of operation is of prime importance."

LET OUR ENGINEERS HELP SOLVE *YOUR* POWER PROBLEMS . . . Whether or not you're at work on defense projects, the answer to *your* power problem is figured in terms of fuel cost, reliability, boiler efficiency, steam cost and maintenance charges. Chesapeake and Ohio Fuel Service Engineers are on call to help you get more for your power dollars. Their services are offered absolutely without charge. If you'd like them to survey your plant, consult with your engineers and offer money-saving, efficiency-boosting suggestions, simply write to GEO. H. REINBRECHT, Coal Traffic Mgr., Chesapeake and Ohio Lines, 2901 Terminal Tower, Cleveland, Ohio.

IT PAY$ TO U$E MODERN . . .

Chesapeake and Ohio Lines



Ever have trouble repacking the stuffing box of a valve because sediment had accumulated in the bonnet chamber? That can't happen with the *top* seat in Fairbanks Plug Valves. A tight seat is always certain because the shoulder on the stem which engages the seat in the bonnet is ABOVE the threads on the stem.

This tight closing feature makes it impossible for scalding steam or hot liquids to escape and burn your hands when repacking the stuffing box under pressure.

This method of top seating also eliminates the possibility of pitting or scoring which occurs when the seating surface is in the stream line.

Another outstanding feature of these valves is the wide sealing surface in the seat and disc and the angle of the plug. This construction distributes the stream flow so it is never concentrated in one position and gives protection against galling and wire drawing. These parts can be replaced easily and quickly, or reground, without removing the body from the pipe line.

Throughout, you'll find many other instances of the unusual care used in the design and manufacture of Fairbanks Plug Valves.

You can get Fairbanks Valves in bronze and iron for practically every condition. Write for name of our nearest distributor and Catalog No. 21.

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Boston, Mass., Pittsburgh, Pa. Distributors in Principal Cities
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Fairbanks F
Standard and Renewable **Valves**

Gas-Engine Cooling

(*Continued from page* 118)

frigeration; electric power required is less than 0.1 kwhr per ton of refrigeration.

In industrial ice-making plants, using engine-driven compressors, waste heat from the engines can be used to operate an absorption-refrigeration unit acting as a forecooler on ice-tank water and as a precooler for high-pressure liquid ammonia before it enters the low-side coils of the compression system. The standard ammonia-water absorption system may be used in this hookup, but at the low steam pressure available from a heat-recovery system, steam consumption of these units is high. However, an ice plant operating as described above can theoretically produce the same quantity of ice per 24-hr period as with a straight compression system, with a 5 to 10% smaller ice tank, with 25% less compressor capacity, with 25% less engine hp and with a reduction in specific fuel consumption, per ton of ice delivered, of approximately 20%.

The Southern Counties and Southern California Gas Cos are now engaged in basic research on a new cycle of absorption refrigeration for application to this particular problem. It is expected that the specific steam rate can be reduced by about 30% over the ammonia-water cycle and that the equipment will be somewhat smaller and less expensive to build.

The results of the work being done under Glenn Miller's direction will be embodied in an absorption-refrigeration unit to be operated by waste-heat from approximately 1600 hp of natural-gas engines now driving pumps and generators for the Glendora Irrigating Co, Glendora, Calif. The engines will be equipped with vapor-phase cooling systems and the resultant refrigerant effect will be used for ice making.

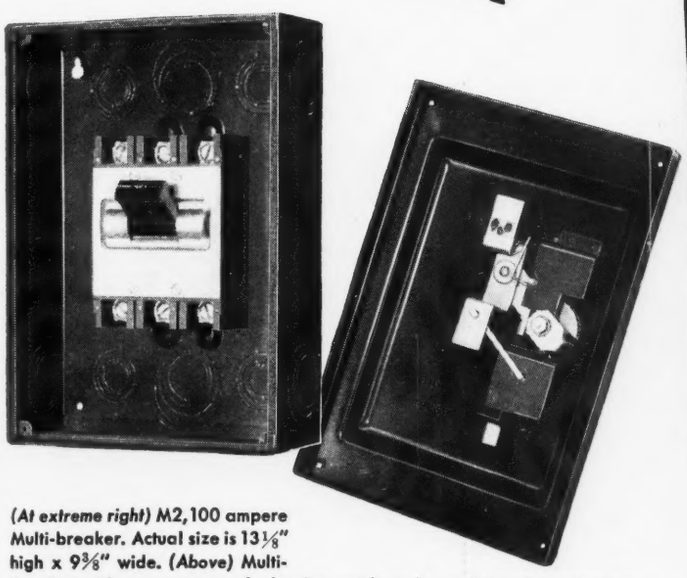
[*Editor's Note: Because these results depart from conventional theory, we asked Mr Clark and Mr Wallace to supply further details on the test methods used and on the heat-flow analysis of the results. This interesting and significant information will be published in a forthcoming issue.*]

HOW ARE WE DOING?

You can help POWER become more useful to you by filling out the reader-preference card on page 179.

SQUARE D *Offers*

A NEW LOW COST INDUSTRIAL MULTI-BREAKER



(At extreme right) M2, 100 ampere Multi-breaker. Actual size is 13⅛" high x 9⅜" wide. *(Above)* Multi-breaker with cover removed, showing quick make and break mechanism designed especially to prevent injury of breaker lever.

A COMPACT CIRCUIT BREAKER TO MEET ALL 230 VOLT A• C• REQUIREMENTS

No parts to replace after short circuit or overload.

Thermal element (bimetal) affords time lag on momentary overloads. New magnetic feature assures instantaneous trip on heavy short circuits.

Window signal on name plate indicates "tripped."

Breaker units are common trip—cannot cause single phasing of circuits.

Front operation permits close ganging.

Provision for padlocking in "on" or "off" position.

Dust-resisting construction; felt gasket between box and cover.

Compact—50 ampere size measures only 11⅛" high x 6⅝" wide. The 100 ampere size (as illustrated above) measures 13⅛" high x 9⅜" wide.

Immediate Delivery On All Sizes
—Notice Low Costs

Frame Size	Amps.	2-Pole List Price	3-Pole List Price
M1	15-25	$10.00	$15.00
50 Ampere	35-50	14.00	19.00
M2 100 Ampere	50-100	24.00	33.00

Write us for Bulletin 3200, which gives detailed description and specifications of this new Multi-breaker.

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THREDOLETS

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A Branch Pipe Outlet Every 2½ Ft. Without Cutting or Threading the Main Pipe

WeldOlet

IN erecting two 500′ steam lines in a large southern paper mill, it was necessary to provide 400 branch "take-offs"—approximately one every 2½′.

Bonney WeldOlets and ThredOlets were selected because they eliminated all cutting, threading, fitting and forming of the main line and because they made a neater installation and reduced its total weight.

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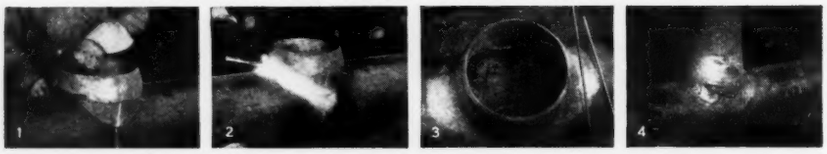
In addition to the tremendous savings in time and labor cost of installation, these fittings provided the additional advantages of lifetime leak-proof joints of full pipe strength and definitely improved flow conditions.

WeldOlets and ThredOlets are recommended for all commonly used pressures and temperatures in every type of piping installation. Any welder of average experience can do a perfect installation job quickly and easily.

Socket-End WeldOlet

For maintenance, renovation or new construction WeldOlets and ThredOlets will give you improved piping efficiency at lower cost. Get full information now about all of their advantages.

AS EASY AS LIGHTING YOUR PIPE



(1)—Select the position of the outlet, rub the fitting over the pipe several times to remove scale, mark center lines and tack the WeldOlet or ThredOlet into position. (2)—The fitting is then welded into place by the electric-arc or oxy-acetylene method. A junction of full pipe strength and a leak-proof joint is the result. (3)—Where the outlet is 2" or larger the button should be removed after the welding operation. On small sizes the fitting is used as a templet and the hole is cut in the main pipe first, either with a hole saw, the torch or by drilling. Inspection of the inside of the joint is possible by using WeldOlets and ThredOlets, allowing the removal of all scale, welding metal, etc. (4)—The branch line is then welded into position. In the event that a ThredOlet is used the branch pipe is threaded and screwed into place.

BONNEY FORGE & TOOL WORKS

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The Finest that Money Can Buy

BONNEY TOOLS

Engineers' Books

(*Continued from page* 132)

been retained and some new material added. The entire volume has been reconciled with the 1940 Code, including the tables in the appendix so that the treatment deals with present-day methods and requirements.

The work has been divided into three parts: First, simple theory and basic principles, which includes electrical devices and circuits, protective devices, types and sizes of wires and their selection. Second, actual wiring—residential and farm—dealing with the planning of installations, installation of circuits and equipment, wiring apartment houses and changes in the 1940 NE code. Third, actual wiring—non-residential projects—such as industrial lighting, wiring for motors, etc.

A 30-page appendix includes tables useful in laying out wiring installations. The subjects are presented in down-to-earth terms, simple enough for beginners, yet complete enough to be valuable to experienced electrical workers.

Diesels for Airplanes

OXYGEN-BOOSTING OF DIESEL ENGINES FOR TAKE-OFF (1941). *By P H Schweitzer and E R Klinge, The Pennsylvania State College. Bulletin No. 54, The Pennsylvania State College Engineering Experiment Station, State College, Pa. Price $.50.*

Outlines procedure and results of investigation into effect of feeding oxygen into the air-intake of a diesel engine. The increase in power output without detonation produced by oxygen feeding indicates possibilities for supplying the high-power requirements for the takeoff period of aircraft, without proportionate increase in engine size over that required for cruising.

Oil Burners

CORRECTING OIL BURNER DEFICIENCIES (1941). *By Zuce Kogan, Consulting Engineer. Published by Zuce Kogan Consulting Service, 724 Sheridan Rd, Chicago, Ill. 152 pages, 6½x9 in., illustrated. Price $5.00.*

A lengthy discussion of the effect of forced-draft air pressure on the combustion of fuel oil in furnaces arrives at no definite conclusion. Careful reading discloses much space devoted to defense of the author's "new" concept of fine, thorough and rapid mixing of air and

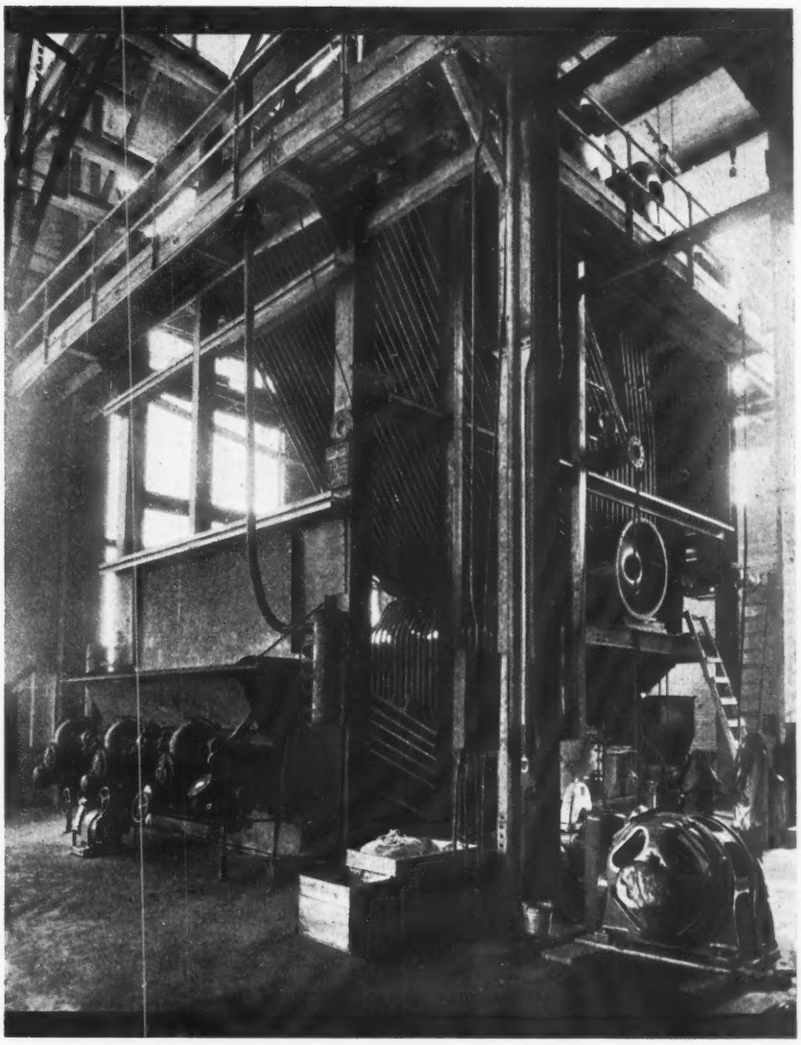
(*Continued on page* 146)

DO YOU WANT TO SAVE TIME *in getting extra boiler capacity . . .*

Consult EDGE MOOR

You can get around the long delivery problem by selecting an Edge Moor Boiler of any size or type that has been built and previously installed. This applies to water tube boilers in a wide range of types and capacities.

If you're looking for a way out of your difficulty in getting more steam in a hurry—if you want to short cut the delivery situation—get in touch with EDGE MOOR Today. Our engineers can be of valuable assistance—our shops are set up for fast fabrication.



A TYPICAL EDGE MOOR INSTALLATION WHICH CAN BE DUPLICATED QUICKLY . . .

This 4-drum unit was installed by Edge Moor for the Sylvania Industrial Corporation, Fredericksburg, Va. Boiler is 1023 HP with a capacity of 120,000 lb. of steam at 450 lb. pressure and 602° F. Equipment, also, erected complete by Edge Moor includes underfeed stoker, superheater, economizer and water walls.

FULL RESPONSIBILITY AVAILABLE FOR COMPLETE BOILER PLANTS including BOILERS, SUPERHEATERS, STOKERS, WATER WALLS, ECONOMIZERS, AIR PREHEATERS in cooperation with your Consulting Engineers.

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Automatic

COAL CRUSHER *and* SAMPLER

If you're running your plant day and night to supply power for defense production, Sturtevant offers you an opportunity to make real savings in your coal buying. Here's how:

Feed your coal and coke into the Improved Sturtevant Automatic Coal Crusher and Sampler and get samples that are truly representative of all material passed through, crushed to a fineness of practically all minus 8 mesh screen size. Provision is made to obtain 5, 10 or 15% samples as desired.

32 HAND OPERATIONS ELIMINATED

By the Sturtevant method—32 of the 34 tedious operations ordinarily required by hand sampling are eliminated. In addition, greater accuracy and speed of sampling are assured. Ability to obtain and compare accurate samples of every barge or car of coal enable you to know exactly what you are paying for in terms of BTU's and thus determine the most economical coal for your purpose—and you *get* this important information before you burn it—insuring better boiler performance, lower maintenance and savings in your fuel bill. INVESTIGATE TODAY: SEND FOR BULLETIN 85.

For Savings . . .

"SAMPLE YOUR COAL BEFORE YOU BURN IT"

Sturtevant Mill Co.

103 Clayton St., Dorchester, Boston, Mass.

oil particles. Some practical information, mostly of extreme generality, is buried in a maze of dissertation on the difference between mixing oil with air and mixing air with oil.

Section headings include (1) a new concept of fuel oil burning (2) mixing of oil and air (3) furnace heating zone (4) fineness of atomization (5) burner application. Anyone with five dollars is welcome, but not encouraged, to read this book for the good it will do his patience.——SAT

Psychometric Tables

PSYCHROMETRIC NOTES AND TABLES (Revised Edition, 1941). *By Elmer Torok, Supt of Power, North American Rayon Corp. Published by North American Rayon Corp, 261 Fifth Ave, New York, N. Y. 125 pages, 4½x6¾ in., flexible binding. Available to interested engineers.*

The response to the first edition of this handy pocketbook demonstrated its usefulness to those constantly working with psychrometric problems. With revised and amplified text, this edition fulfills two basic purposes: (1) it serves as a guide to making psychrometric computations of all kinds, and (2) it gathers in one place all the necessary information for the solution of such problems.

The text and tables cover, in turn, definitions of psychrometric terms, tables of psychrometric factors, examples and solutions of psychrometric problems, heat-transmission coefficients, solution of heating- and cooling-load problems, and conversion factors frequently used in this field.

The author and his organization are to be congratulated on putting such a wealth of useful information into a practical and highly helpful form.

Diesels

THE HIGH-SPEED COMPRESSION-IGNITION ENGINE (1941). *By C B Dicksee. Published by Blackie and Son Ltd, London (Interscience Publishers Inc, 215 Fourth Ave, New York, N. Y.) 331 pages, 5½x8½ in., 165 illustrations, 26 tables. Price $4.50.*

This book deals with the principles of "high-speed" engines rather than with descriptions of existing types. The author has been closely associated with the practical development of engines for road transport and thus speaks with authority. Major attention is focussed on the various phases of the combustion process, the crux of the high-speed problem; an entire chapter is devoted to

K&M INSULATION S-T-R-E-T-C-H-E-S WITHOUT CRACKING AS GIANT STEAM LINE EXPANDS

Part of the steam line leading from the new "topping" unit of a large middle western utility company. Insulated with K&M Hy-Temp Combination insulation.

In the new 60,000 KW "topping" unit recently added by a large middle western utility company, the lines from boilers to turbines carry steam at 925°F. and 1300 p.s.i. Incorporating the most modern advances in power plant design, this unit wrings every last B.T.U. from its fuel, and safeguards its full steam energy every inch of the way by means of high efficiency Keasbey & Mattison insulation.

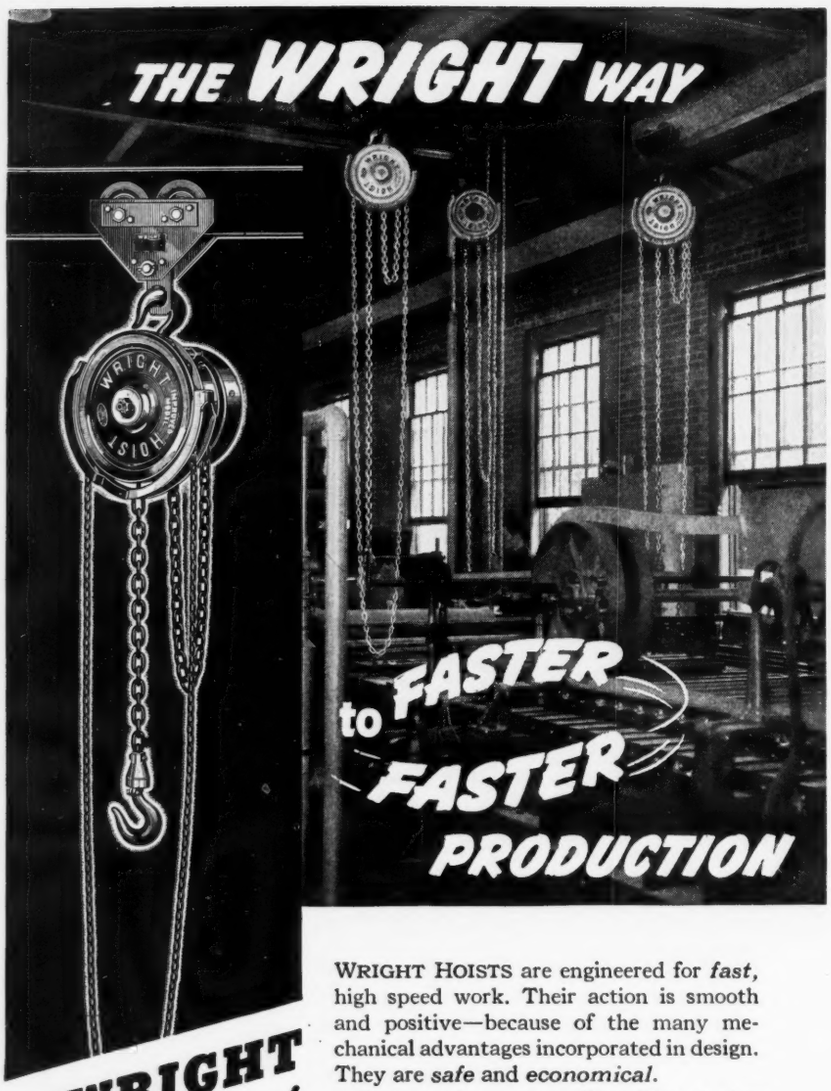
But 650 feet of steam line is bound to expand when heated to 925°F. How was the insulation to be prevented from cracking? Keasbey & Mattison engineers had a ready solution for this problem. They developed a sealed expansion joint that stretches and continues to insulate as the giant pipe expands. Because of it, there is not a single chink in the armor of this K&M installation.

Not only will you find K&M heat insulations outstanding in their efficiency, but you can rely on K&M engineering service to analyze and solve your problems. K&M engineers, working with K&M Distributors strategically located throughout the country for quick service, can point the way to real savings in your plant. Write Dept. 11 for full details.

K&M "Featherweight" 85% Magnesia

KEASBEY & MATTISON

COMPANY, AMBLER, PENNSYLVANIA



WRIGHT *Improved High Speed* **HOISTS**
¼ TO 50 TONS

WRIGHT HOISTS are engineered for *fast*, high speed work. Their action is smooth and positive—because of the many mechanical advantages incorporated in design. They are *safe* and *economical*.

Fortunately, we are well qualified to give you specialized engineering service. Let us tell you of some of the individual hoisting problems we have studied and solved, then designed and built hoists to fit.

And in everything we design, *safety* is an in-built feature. The load chain has a safety factor of 7 to 1. It is made of a special process steel which permits the chain to elongate (under overload) 3″ to the foot before breaking. A similar visual factor of safety is inherent in the bottom hook which will slowly open to indicate overload beyond the elastic limit of the chain.

WRIGHT TROLLEYS are made to give the same *fast, economical, safe* service as Wright Hoists. Write for your copy of the new Wright Catalog and learn the 21 points of WRIGHT superiority.

Let Wright engineer your hoisting and crane problems. Work through the Wright distributor in your city. You'll find him listed in the classified telephone book.

WRIGHT MANUFACTURING DIVISION
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AMERICAN CHAIN & CABLE COMPANY, Inc.
In Business for Your Safety

analysis of air movement in the cylinder of a compression-ignition engine. Particular interest also attaches to a close study of the characteristics of injection systems and how they affect engine operation.

For the specialist in the high-speed-engine field, there is much of interest and value in this book, particularly the view it gives of practice and research in Europe.

Air Conditioning

PRACTICAL AIR CONDITIONING (1941). *By Adolph J Rummel and Lewis O Vogelsang. Published by John Wiley & Sons, Inc, 440 Fourth Ave, New York, N. Y. 282 pages, 5½x8½ in., 61 illustrations, 49 tables, cloth binding. Price $2.75.*

Based on experience gained through many years of consulting and advisory work with owners, manufacturers, contractors, dealers, salesmen, service men and operators of all types of heating, ventilating, and air-conditioning equipment, this book is concerned with the practical aspects of the field. It is written in simple and non-technical language as an introduction for those now engaged in the industry or those who wish to enter it.

The text covers fundamentals and definitions, the properties of air, the requirements for human comfort, types of equipment, methods of operation, and servicing methods and schedules. Operating engineers interested in air conditioning may find this book a helpful step toward some of the more advanced texts.

Blueprint Reading

MACHINE TRADES BLUEPRINT READING. (1941). *By Russel W Ihne, Asst Supervisor of Industrial Education of Indiana, and Walter E Streeter, Industrial Engineer, Aluminum Co of America. Published by American Technical Society, Drexel Ave & 58th St., Chicago, Ill. Spirally bound in heavy pyroxlin coated paper, contains 166 pages, 8½x11 in., of blueprints, questions and graph paper. Price $2.00.*

Here is a practical book based on actual production blueprints with many questions and answers adapted to home study as well as for use in vocational-school class rooms. The first part of the book is designed to teach basic information necessary to interpret blueprints. It covers the alphabet of lines, methods of projection, relation of views and an understanding of dimensions. Problems in shop mathematics review

IF AUTOMATIC COMBUSTION CONTROL *for your plant . . .*

COULD BE PURCHASED AT CONSIDERABLY LESS THAN YOU PREVIOUSLY FIGURED . . .

Wouldn't You Find It *Advantageous* To Change To It Now?

CASH STANDARD AUTOMATIC COMBUSTION CONTROL

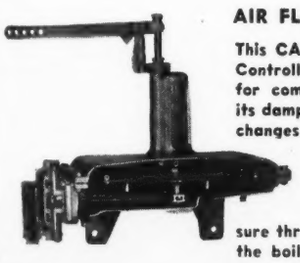
★ Specifically designed to meet every requirement—whether you have a stoker, pulverizer, oil-burning, or gas-firing equipment on your boilers.

CASH STANDARD AUTOMATIC COMBUSTION CONTROL may prove very interesting to you in the matter of original cost. But you can look beyond that saving and get some interesting facts on how you can operate your boiler room for less with this equipment — and also put your boiler room on a high efficiency basis. The savings come in smaller fuel bills and more steam — in reduced maintenance, giving your operators more time for other important duties — plus all this you hold your steam pressure within close limits — you maintain the fuel air ratio that is correct for economical combustion — you hold over-fire draft to minimum to prevent infiltration of outside air and undue stack loss.

FURNACE DRAFT CONTROLLER

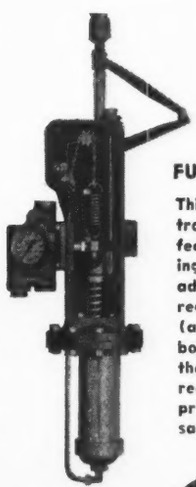
This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper to maintain a constant draft in the combustion chamber. Place it near the uptake damper. It works independently of either of the fuel feed and air flow Controllers. If it only eliminated wasteful air infiltration it would be a profitable investment.

★ Bulletin No. 300 gives you a quick picture of the accuracy, simplicity, and dependability of CASH STANDARD Automatic Combustion Control. Send for your copy.



AIR FLOW CONTROLLER

This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.



FUEL FEED CONTROLLER

This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.

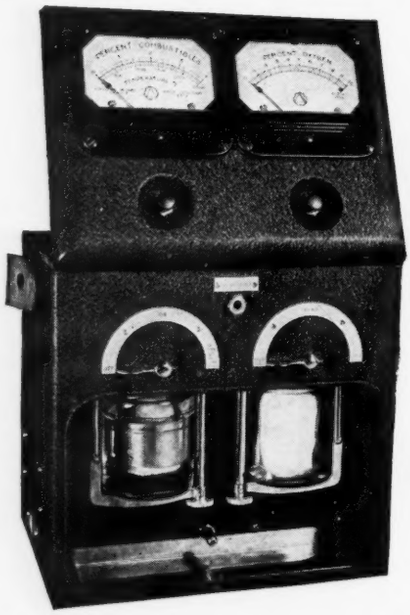
OIL CIRCULATOR

The purchase of this oil circulator is optional. All three Controllers shown above can be properly operated by clean water, but it is preferable and cheapest in the long run to operate with this CASH STANDARD Oil Circulator — price $108. equipped with 110-220 v. 60 cy. motor.

A. W. CASH COMPANY
DECATUR, ILLINOIS

CASH STANDARD
CONTROLS . . VALVES

Users of CITIES SERVICE LUBRICANTS get an EXTRA ADVANTAGE with HEAT-PROVER SERVICE



Heat-Prover Service is now available to users of Cities Service Industrial Fuels and Lubricants. This is an economy measuring service which you can secure in addition to the quality and economy advantages offered by Cities Service's SERVICE PROVED Fuel and Diesel Oils.

The Heat-Prover is an ingenious device — a by-product of our research in metallurgy. It registers continuously and instantaneously changes in the amount of oxygen and combustibles in furnace gases. It is an excellent guide in adjusting 4-cycle Diesels and for combustion control in heat generating plants. In the heat treatment of metals, it is invaluable. It assures uniformity and reduces scrap losses.

Let us tell you how you can secure the use of one of these machines. Mail the coupon today for further information.

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FREE—Just clip and mail

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Room 1326, Sixty Wall Tower, New York

Please tell me how I can get Heat-Prover Service in my shop. PR.

Name .....

Name of Shop .....

Address .....

City ..... State .....

the manipulation of numbers, fractions and decimals and their application to checking dimensions.

Following the beginning blueprints, a number of production blueprints are given typical of those the student will use on the job. A question sheet accompanies each print with space for writing in the answers. Answers and solutions are contained in a separate packet, given with the book. Graph paper for making sketches is also included.

New Plant Equipment

(*Continued from page 128*)

driven compressors. Power ends of units equipped with Unaflow steam cylinders.

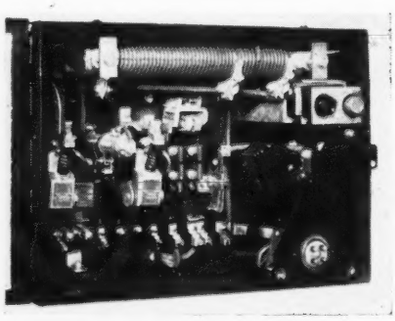
Particular features are small floor space requirements, according to manufacturer, low foundation and building costs, economical steam rates, flexibility and minimum maintenance costs. *Clark Bros, Olean, N. Y.*

Service Lamp

VIBRATION-SERVICE LAMP has construction which protects filament from vibration and jars, and is designed particularly for industrial and commercial use where high-frequency vibration set up by motors and machinery in constant use tends to weaken average bulb-filament and shorten its life. Lamp has same over-all appearance as ordinary bulb, but is made in larger oversize bulb of wider diameter to increase convectivity of heated argon and nitrogen gases inside bulb. This allows lamp to burn cooler. Filament is cushioned against shock and concussion of vibration by four molybdenum pigtail springs welded to six flexible filament supports. *Wabash Appliance Corp., 335 Carroll St, Brooklyn, N. Y.*

Combination Starter

REMOTE AND AUTOMATIC CONTROL for mining equipment such as conveyors, pumps, fans, etc, provided in dc combination starter. Safety features include line-disconnecting switch, low-voltage protection, combination thermal, instantaneous overload



This Kennedy Valve

is made of metal 50% stronger than ordinary cast iron

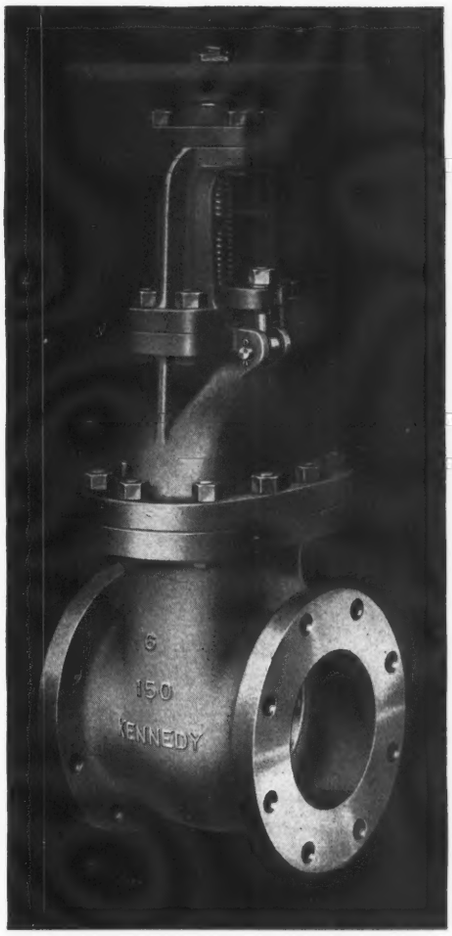
has bronze bushings at all stem contact surfaces

has rust-proofed stuffing box bolts and nuts

has special provisions to maintain alignment of the stem

has no studs at bonnet or yoke—bolts are used throughout

. . . and has more than two dozen other advantageous features



Kennedy Standard Iron-body Wedge Gate Valve. Fig. 0611

HERE is a valve design that has every security, convenience and refinement you would recommend from your own experience in using valves.

The bodies will not distort, because of their strong oval shape, well-filleted at all corners, and heavy section reinforced at neck and flanges. The discs will not spring, because of their heavy supporting posts and long body guides.

The design has special provisions for ease of connecting up, operating, and repacking, and many of its refinements that promote dependable service and long life are not obtainable in any other design.

These valves set a new standard of quality and service—at standard market prices.

The new Kennedy catalog 63 describes these "Extra-Value" Kennedy Valves in detail. Write for your copy.

The Kennedy Valve Mfg. Co., Elmira, N.Y.

KENNEDY

Iron-Body *Wedge* Gate Valves

R/M PACKINGS

Mean Smooth Performance

Raybestos-Manhattan is eager and able to keep that "3-ring circus" of yours under control. Steam or oil, gas or water, R/M packings keep them moving steadily and smoothly under perfect control, with the very minimum of wear and tear.

It has taken over 40 years' leadership in fabricating asbestos and rubber for American industry to arrive at the present complete but small R/M line, in which all duplicates are eliminated, full stocks are immediately available, and each is the very finest product for its task.

Let R/M crack whips over your horsepower. Start by having your personal copy of the R/M catalog.

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This condensed, cross-indexed, photographic catalog is for you. It will help you specify quickly and save money. Ask your local R/M distributor, or write us direct for your copy.

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RAYBESTOS-MANHATTAN, INC.

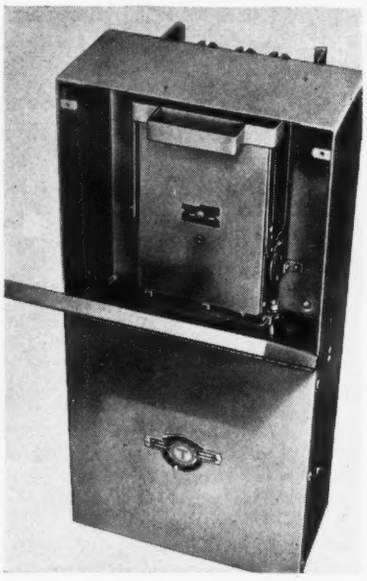
Makers of Packings for Every Industrial Use

BRIDGEPORT, CONN. MANHEIM, PA. NORTH CHARLESTON, S. C. PASSAIC, N. J.

protection, and safety interlocks to prevent door opening unless switch is off. When disconnecting switch is closed and start button pushed, line contactor closes, starting motor with resistance in circuit. Coil of accelerating contactor is connected across motor armature, and as motor accelerates, voltage across armature increases and causes accelerating contactor to close at proper time. This short-circuits resistor and connects motor across the line. When accurate definite speed is desired, small adjustable field rheostat may be added which provides to 15% increase in speed. *Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

Circuit Breaker

FLEX-A-PLUG CONSISTS OF HEAVY-DUTY SWITCH or Type AT circuit breaker in combination with pyranol-filled capacitor. Plug can be used to improve power factor of system, or, if overload conditions exist,



reduce current to within safe limits and reduce losses through heating because of lower currents. Capacitor plugs can be distributed in approximately same manner as load, and are easily installed and moved as loads are relocated. *Trumbull Electric Co, Plainville, Conn.*

Control Lenses

FLUORESCENT CONTROLENSES are prismatic lenses which, when used with fluorescent fixtures, will produce three basic distribution lighting patterns. First, known as intensive Controlens, produces distribution of light most commonly used in both commercial and industrial interiors—normal "uniform spacing" lighting of horizontal surfaces in rooms of normal height. Second, concentrating Controlens, produces rigidly confined focusing-type of light distribution, and third, extensive Controlens, is particularly adaptable for areas where lighting of vertical surfaces is desired. or in low-ceiling areas to permit economical

For those who seek top value—GULFCREST

Unmatched by any other turbine oil
GULFCREST OIL
4 Reasons Why
GULFCREST is the turbine oil of unparalleled quality
1. REFINED BY THE ALCHLOR PROCESS. The most thorough and effective method for removing chemically active hydrocarbons as well as the general run of impurities present in all crudes.
2. HIGHEST RESISTANCE TO OXIDATION. Because this famous ALCHLOR Process synthesizes and rearranges the molecular structure of certain hydrocarbons, resulting in a finished product of greater stability, GULFCREST OIL stands alone in its high resistance to oxidation.
3. HIGHEST RESISTANCE TO ACIDITY AND SLUDGE. Because of the elimination of oxidation catalysts in addition to the unparalleled refining power of the Alchlor Process, these oils form less gum and deposits, less emulsion and sludge, when mixed with water over a period of several years continuous operation, than any other turbine oil of which we have record.
4. HIGHEST KILOWATT-HOUR PERFORMANCE. Because Alchlor not only makes possible an oil more thoroughly refined and homogeneous, but also creates anti-oxidants, these oils have great resistance to deteriorating influences and are longer lived. Less makeup oil is required.
GULF INDUSTRIAL LUBRICATION

GULF OIL CORPORATION · GULF REFINING COMPANY · PITTSBURGH, PA.

SAVE TUBE CLEANING TIME AND INCREASE PRODUCTION— USE WILSON TUBE CLEANERS

In hundreds of plants now producing materials and equipment essential to our national defense, Wilson tube cleaning equipment is playing a vital part by reducing tube cleaning shut-down time.

There's a Wilson motor, cutter head, brush or other accessory especially suitable for *quickly, efficiently* and *economically* removing hard or soft scale from *any* straight or curved tube—of ferrous or non-ferrous metal—of large or small diameter—that can be cleaned mechanically.

Let us help you solve your tube cleaning problems. Send for the name of our representative nearest to you or for a copy of our thirty-six page catalog fully describing and illustrating the complete line of Wilson tube cleaning equipment.

THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
47-28 37th Street Long Island City, N. Y.

ALLPAX
THE PACKING THAT "PACKS ALL"

. . . use it once and
. . . you'll use it always

THE ALLPAX CO., INC.
Mamaroneck, N. Y.
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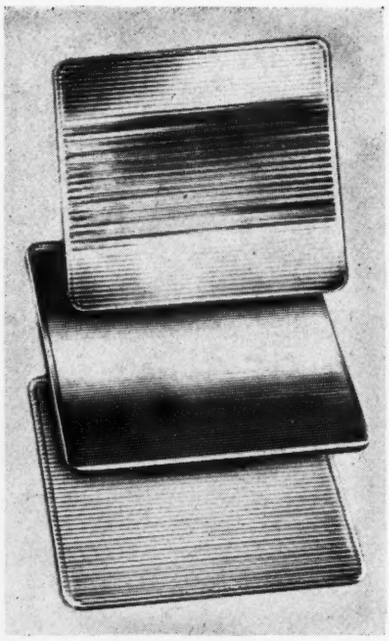
Distributors Everywhere

Here's the universal packing that can be used for any fluid or on any apparatus. One size packs all—economically, efficiently—tightly—simply.

Try ALLPAX and you, too, will be enthusiastic over its easy application and long wear. You don't have to remove old packing to repack with ALLPAX. Square cross section makes ALLPAX easy-fitting in any stuffing box.

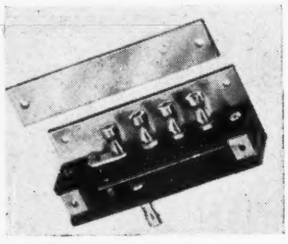
Try it and you'll always use it. Full details on request.



wide spacing of units. Fixtures using Controlenses available, for recessed-flush, close up and suspension mounting. *Holophane Co, 342 Madison Ave, New York, N. Y.*

Time Delay Switch

SWITCH DEVELOPED to provide predetermined time delay in electrical control. Designed for laboratory and industrial application in conjunction with magnetic relays and generally used where temperature

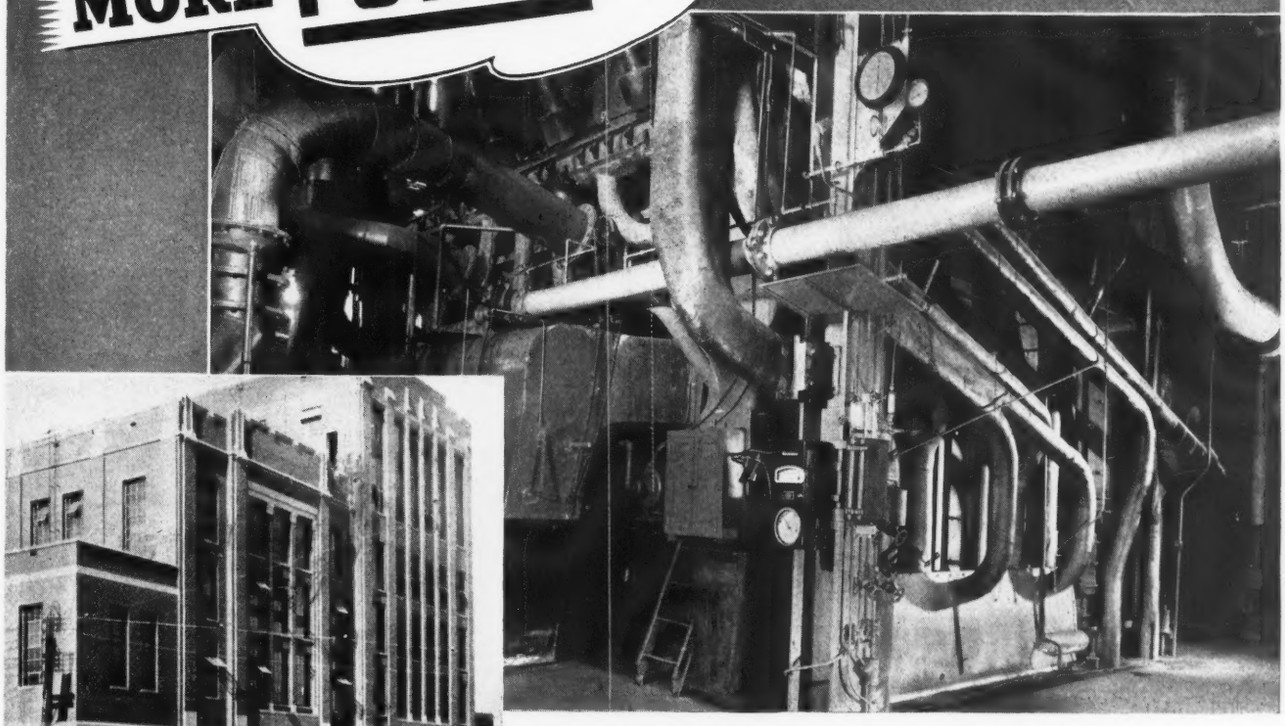


changes are fairly constant and slight variations in timing are not detrimental. Units are provided with four terminals, two for heater coil, two for main circuit and adjustable within time limits of one second to five minutes. *Betts & Betts Corp, 552 West 52nd St, New York, N. Y.*

Pipe and Tube Cleaner

NEMCO solution-feed sanitary pipe and tube cleaner consists of 20-, 40- or 60-gal solution tank mounted on ball-bearing casters. On top of this is mounted totally enclosed motor, different sizes for different capacities, which drives automatic over- and underload compressor, and 15-ft rubber-covered flexible tube cleaning shaft. This has special adapter to take solution feed scrubber handle. Solution is forced from the tank by air pressure created by compressor, which unloads itself automat-

MORE POWER TO LINCOLN



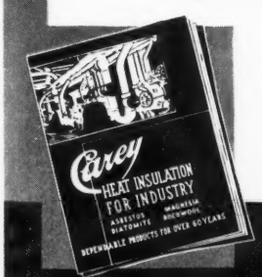
Carey HEAT INSULATIONS

REPEAT IN NEW POWER PLANT EXPANSION

• Responding to the growing power demands of Lincoln, Nebraska, the Iowa-Nebraska Light & Power Company has increased the capacity of its "K" Street plant. The new maximum capacity of the plant is 160,000 lbs. of steam per hour, at 750°F. and 600 lbs. per sq. in. pressure.

Since the original steam piping in this plant was CAREY Insulated, the selection of these time-proved products for the improvement was a logical choice. Steam lines were insulated with a combination of CAREY Hi-Temp No. 12 and CAREY 85% Magnesia.

Whether you plan new construction or modernization, put your insulation problems up to CAREY for top efficiency. A nationwide organization is at your service. Write Department 16, today for Insulation Catalog.



THE PHILIP CAREY COMPANY • Lockland, Cincinnati, Ohio

Dependable Products Since 1873

IN CANADA: THE PHILIP CAREY COMPANY, LTD. Office and Factory: LENNOXVILLE, P. Q.

YOUR *New* PUMP

In addition to building pumps for the United States industrial defense program to the limit of our expanding capacity, we believe that we can serve also by supplying useful facts and information relative to efficient pump operation and maintenance.

This series of advertisements, although based on Quimby pumps, will contain many cues that apply to other types as well. It is offered in the hope that it will be instructive to those whose experience may be limited and will serve as timely reminders for more highly trained personnel.

Naturally, the first cue to better pumping practice is the selection of the best possible pump for the job.

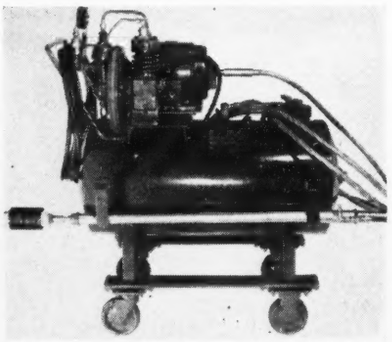
CONCERNING DELIVERY: National Defense priority may cause even our oldest customers some delay in delivery. We earnestly request your patient cooperation until our present expansion program can relieve this situation.

QUIMBY PUMP CO.
INC.
347 THOMAS STREET
NEWARK, N. J.

QUIMBY SCREW PUMPS

. . . GOOD PUMPING PRACTICE SINCE 1894 . . .

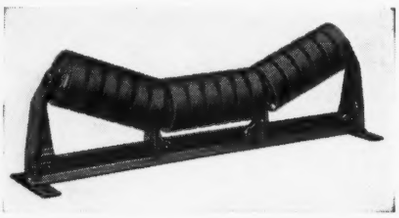
ically. Thus, constant tank pressure is provided, and continuous flow of solution to scrubber and revolving brush is assured. Solution controlled by regulating valve at operator's end of shaft. Scrubbing han-



dles furnished from 12 to 36 in., and tube-cleaning shafts from 3 to 10 ft suitable for tubes from $\frac{3}{4}$ to 6 in., ID. *National Electric Manufacturers Company, 60 East 42nd St, New York, N. Y.*

Impact Idler

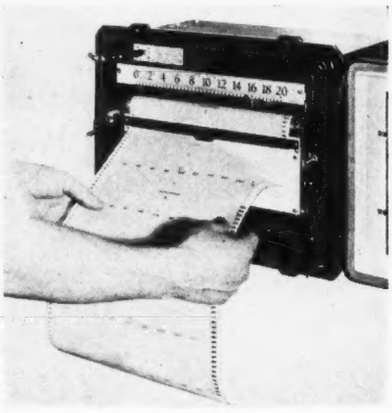
TROUGHING-TYPE, RUBBER-TREAD IMPACT IDLER made to absorb shock of receiving heavy, lumpy, rough materials at loading point. Molded-rubber-tread rolls, 6 in. in



diameter, are secured to roller-bearing equipped tube by set screws through malleable-iron spacers which clamp over reinforced rubber hubs. Idlers available for belt widths of 14 to 60 in. *Link-Belt Co, 307 N Michigan Ave, Chicago, Ill.*

Tear-Off Device

TEAR-OFF FEATURE can be supplied for Celectray recorders and recorder-controllers made by company. Consists of tear-off bar and re-roll with clip and tape. Clip, of special design without springs, grips chart



You whistle while it works

—*if it is Fully Automatic Combustion Control*

WHEN you select a system of automatic combustion control make sure it really *is* automatic.

From the war zone come these reports... "During raid alarms operators rush for shelter and the power plant works by itself"... "Experienced workmen are hard to find but our Hagan Automatic Control still maintains highest efficiency"... "We wouldn't build another station without completely automatic combustion control."

Automatic combustion control should be automatic in *operation* as well as in name. Boiler plants should handle rapid load swings continuously without close attention. With Hagan Control, the *control* does the thinking and makes *all* the necessary changes quickly, surely and safely. Push-buttons and hand-wheels are provided for convenience only, for remote manual operation as occasionally desired.

To power plant operators this means: (1) peak efficiency; (2) minimum fuel consumption; (3) maximum steam output.

Let us prove the advantages of *fully automatic* Hagan Combustion Control. Write for technical details.

HAGAN CORPORATION · 300 ROSS STREET · PITTSBURGH, PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer... and still the leader

firmly after chart section has been removed. Maker states that this feature is useful for daily records as well as complete record of any batch or run. Short chart-strips can be filed for ready reference. *C J Tagliabue Mfg Co, Park & Nostrand Aves, Brooklyn, N. Y.*

Fuel-Oil Meter

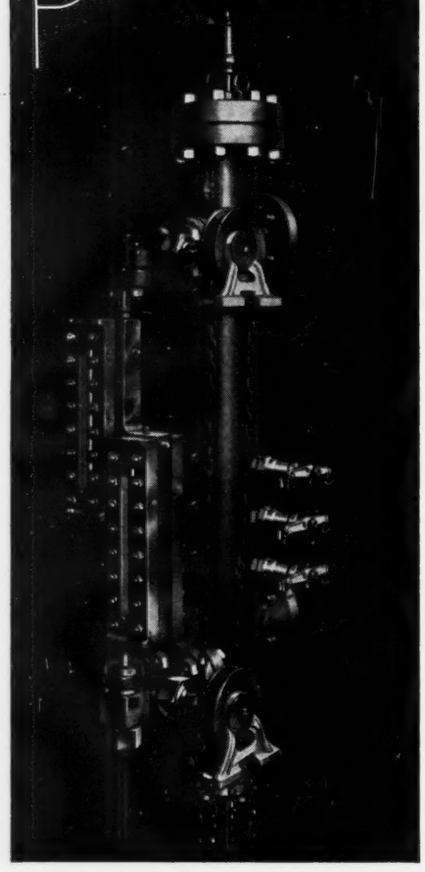
FUNDAMENTAL OPERATING PRINCIPLE of Vesta fuel-oil meter based on oil volume only, rather than speed of oil flow. Can be installed quickly and is automatic in operation. Fuel consumed is registered

continuously by counter which runs to 9999 9/10 gals, then repeats. Maker says meter will maintain accuracy regardless of how small fuel flow rate may be. Meter is used principally for measuring fuel-oil flow to Diesel engines. *Fluid Meters, Inc, 60 Wall Tower, New York, N. Y.*

Air-Injection Stoker Manifold

DESIGNED FOR USE IN SMALL and medium-size steam plants where modernization of existing furnaces is desired, low-pressure air manifold for spreader stokers has ability to spread small sizes of coal in predetermined pattern. Manifold is connected directly to standard 1750-rpm, low-pressure blower. One outlet protrudes directly below each mechanically driven coal-delivery stoker screw. Nozzle shape is worked out to give flat, fan-shaped spreading of coal. Additional advantages claimed by maker

POSITIVE Protection



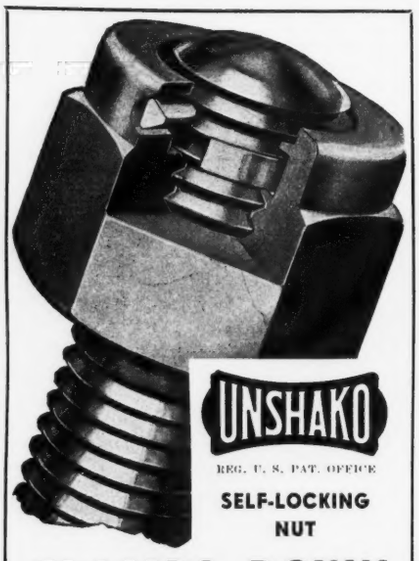
Yarway's unique Hi-Lo Alarm mechanism utilizes balanced *solid weights* that are as indestructible and unchanging as the metal itself. Operating on the displacement principle, they literally "weigh the water level."

When the high or low water emergency occurs—instant, positive, powerful, hair-trigger *action* results—giving warning of danger by whistle, light, or both.

Yarway Water Columns, eight standard models, iron bodies with screwed connections for pressures up to 250 lbs., forged steel bodies with flanged connections for pressures up to 1500 lbs., are fully described in Catalog WG-1807. Write for a copy and working model.

YARNALL-WARING COMPANY
100 Mermaid Ave. Philadelphia

YARWAY
FLOATLESS HI-LO ALARM
WATER COLUMN



UNSHAKO
REG. U. S. PAT. OFFICE
SELF-LOCKING NUT

CLAMPS DOWN on vibration!

On all moving parts of reciprocating engines, pumps, conveyors, generators, stokers, etc.—use "UNSHAKO." The built-in, self-energizing locking ring is always on guard and springs to life as soon as any backing off tendency asserts itself. It's a relentless grip . . . it's real protection! For details, write

STANDARD PRESSED STEEL CO.
BOX 577, JENKINTOWN, PENNA.

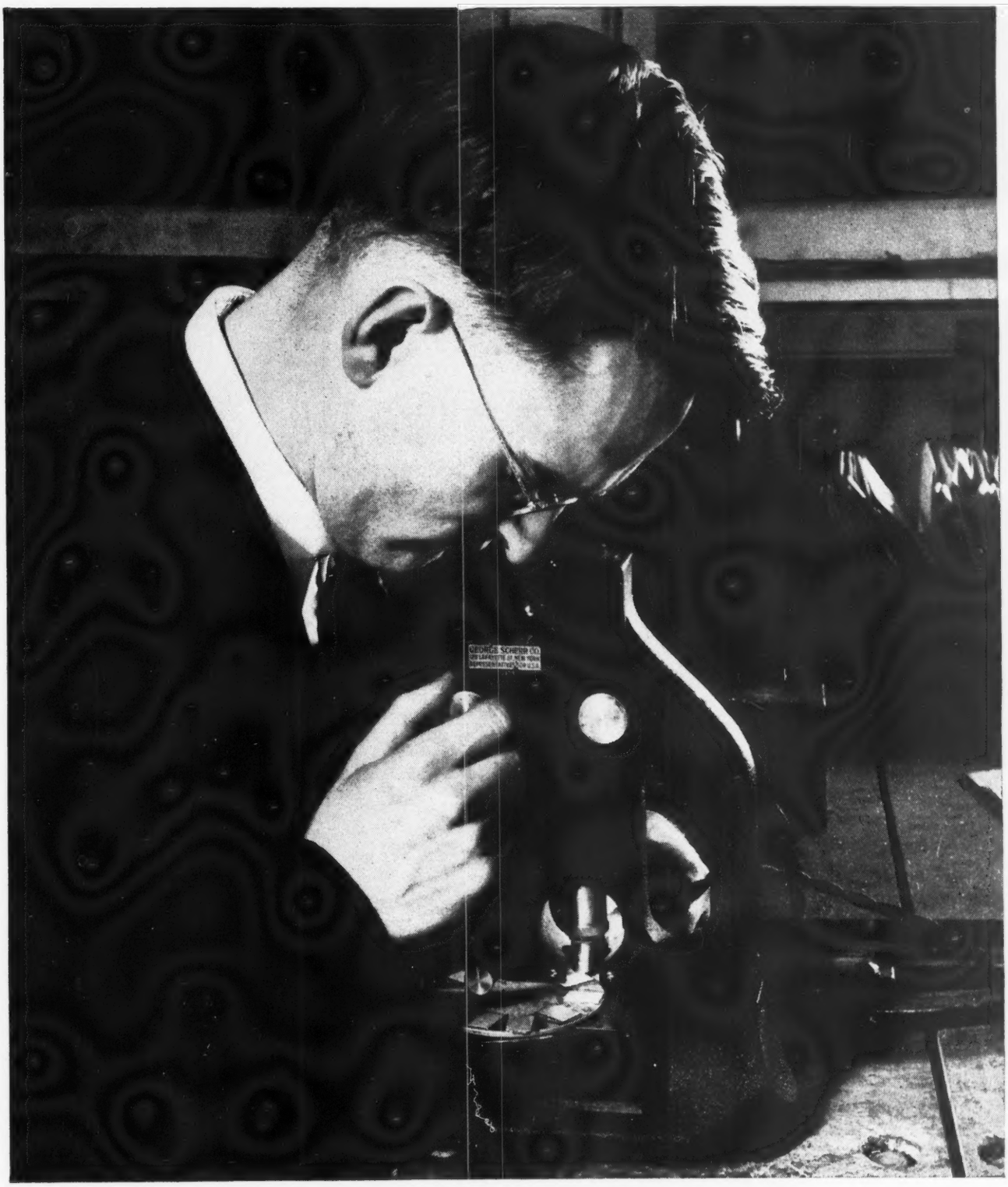
Save Air—Save Dollars

Flanged Slide Type

IT'S like putting money in the bank to replace old style blast gates—the kind that leak, waste power, and "make up" a wobbly line—with Rockwell Blast Gates. These gates have many features that make them the outstanding "buy" in all branches of industry.

Write for Catalog No. 4020

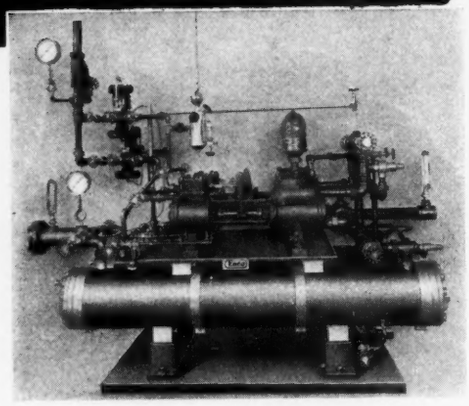
W. S. ROCKWELL COMPANY
Blast Gate Division
50 CHURCH STREET NEW YORK, N. Y.



NEW KIND OF TROUBLE SHOOTER. For many years past, Revere Copper and Brass Incorporated has believed that the best way to avoid trouble is to *prevent* it. Reg Marsland is one of the dozens of Revere's trouble preventers. Step by step as your order goes through Revere's mill, he acts as a "watchdog" on specifications and procedures. The silent unfailing work of the Revere Methods Man is only part of Revere's service. But it is, perhaps, as important in speeding up defense production as any other. For it insures your getting the right metal at the start. Revere Copper and Brass Incorporated, 230 Park Avenue, New York.

ADVERTISING PAGES REMOVED

There's no time NOW for POWER PLANT FAILURE



POWER plant failure is costly at any time — TODAY, it must not happen.

In oil burning plants, ENCO Fuel Oil Pumping and Heating Systems not only deliver oil to the burners safely, and at the proper temperature and pressure, but provide DOUBLE PROTECTION against failure, as well.

Duplicate pumps and heaters are used, each of full capacity. These are interconnected so that operation is obtained with any combination of pump and heater. Screw or rotary pumps, with motor or turbine drive may be furnished, whichever are best suited to the installation.

The finished product is a complete unit, ready to place on foundation and to receive pipe connections.

Write for Instruction Book OBI-38 on the care and operation of Oil Burner Installations; also Bulletin OB-37 describing ENCO OIL BURNING EQUIPMENT.

THE ENGINEER COMPANY
75 WEST STREET Enco NEW YORK, N.Y.

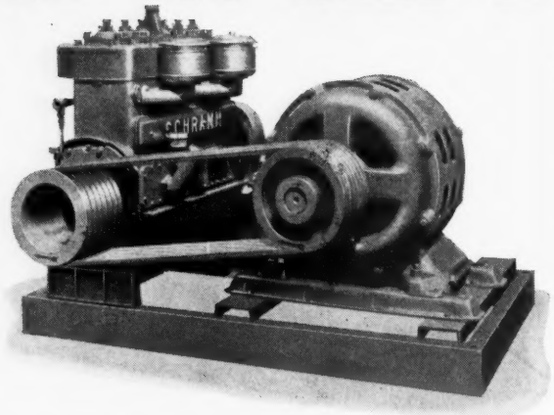
AIR WHERE YOU NEED IT

• QUICKLY •

• EASILY •

At

minimum cost



Our 16 page engineering bulletin 3907 gives complete details and specifications. Write for your copy today.

SCHRAMM compressor with motor, on base. "V" belt drive with 100 hp. electric motor, displacement of 600 cub.ft. of air.

SCHRAMM Stationary Air Compressors provide the means of supplying compressed air service right where it's needed for maximum convenience and use.

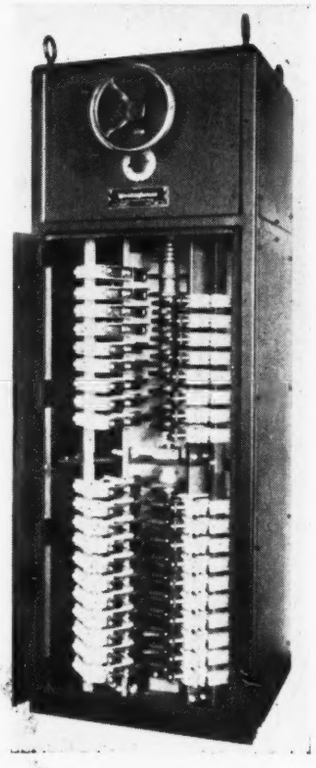
SCHRAMM, INC., WEST CHESTER • PA.

SCHRAMM UTILITY STATIONARY AIR COMPRESSORS

are that manifold eliminates need for high-speed moving mechanical parts within high-temperature part of furnace, automatically supplies over-fire air needed for burning fires in suspension, and simultaneously creates turbulence in furnace chamber favorable to higher combustion efficiency. Units are built with two or more spreader nozzles. *American Coal Burner Co, East Superior St, Chicago, Ill.*

Secondary Controllers

SECONDARY CONTROLLER is for use with polyphase wound-rotor motors on fan, pump, and similar drives. Provides either 13 or 20 balanced points of control by varying external resistance in motor secondary winding. Controller drive mechanism consists of pilot motor, gear-reduction unit, and Geneva gear for angular movement of cam shaft. Step-by-step action is assured by gear and pinion arrangement to move controller one full position or point for each gear revolution. *Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*



Welding Control

CONDENS-O-WELD is complete control designed to include in one floor-mounted cabinet all necessary apparatus required to control electrostatic energy-storage-type of welder. Accessories not included are foot switch, pressure regulator and pressure gage, which are usually supplied by welding-machine maker. Unit is designed for operation on 230/460 volts plus or minus 10%, 3 phase, 50 or 60 cycles. Charging circuit and its control charges a 2640 mfd capacitor bank to 3000 volts. Spot

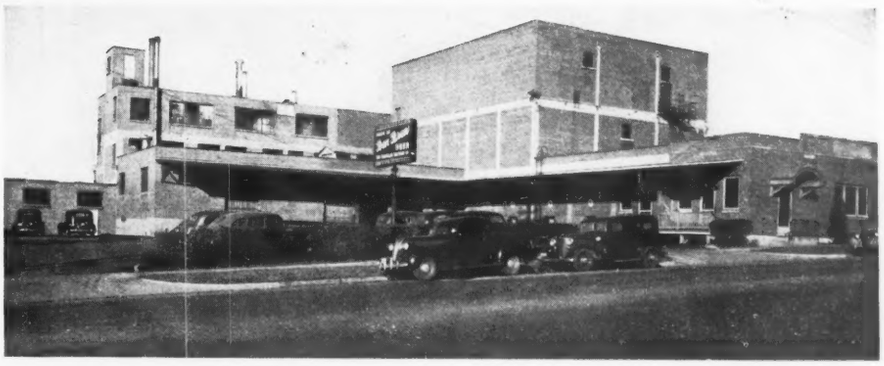
IRON FIREMAN CUTS FUEL COSTS $2458 A YEAR for Franklin Brewing Company

Pays for Itself in 30 Months

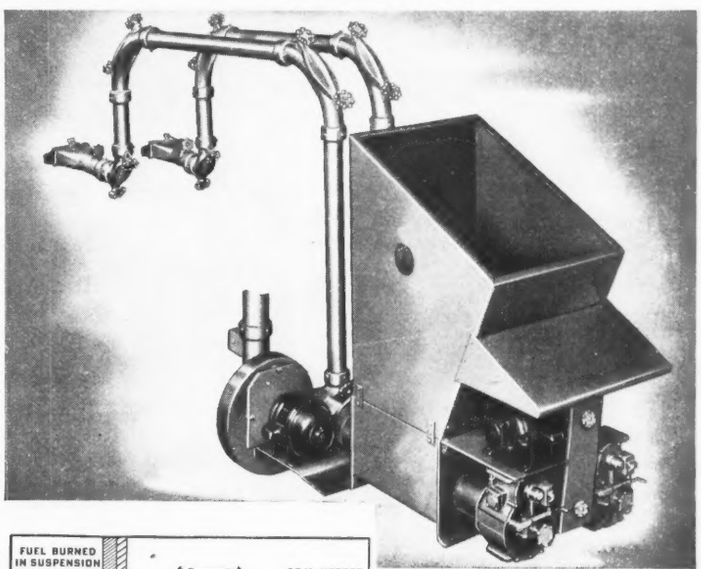
A 40 per cent reduction in fuel costs was the immediate result achieved by Iron Fireman equipment installed by the Franklin Brewing Co., Columbus, O.

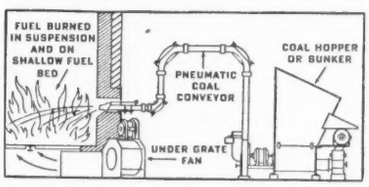
An Iron Fireman Pneumatic Spreader stoker installed in January, 1938, firing two boilers, completely paid for itself in 30 months . . . and **is still returning fuel savings of $2,458 a year.** Franklin Brewery uses steam for process purposes, for heating and for generating electric power. Iron Fireman's consistent ability to meet peak requirements and maintain steady pressure is a valuable extra asset. Iron Fireman's steady performance and sturdy construction have brought about a virtual elimination of maintenance.

Small wonder, then, that Franklin's President, C. E. Gwinn, says: "We are pleased to recommend this equipment to any interested parties."



Plant of the Franklin Brewing Co., Columbus, Ohio, where an Iron Fireman Pneumatic Spreader stoker, dual type, has been firing two boilers, economically and efficiently, since early in 1938.





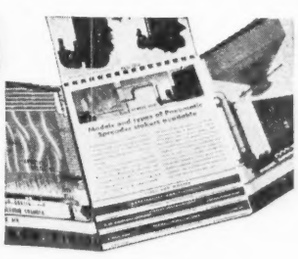
Iron Fireman Dual-Feed Pneumatic Spreader stoker, of the type installed in the Franklin Brewing Company. The installation leaves the boiler front clear, permitting unhindered ash removal and boiler cleaning. Coal can be fed either from bunker or from hopper.

ENGINEERS—Ask for our Free Steam Cost Survey

A savings performance such as that of the Franklin Brewing Company may be possible in your plant. Let an Iron Fireman Engineering Survey show you the savings and betterments possible. Iron Fireman invites collaboration of plant or consulting engineers. There is no obligation. Just send the coupon below.

IRON FIREMAN

Automatic Coal Stokers



SEND FOR FREE NEW PORTFOLIO

Mail coupon, without obligation, for free copy of new Iron Fireman Pneumatic Spreader portfolio. Simple diagrams of stokers, blueprints and operating data of typical installations.
IRON FIREMAN MFG. CO. (Portland, Ore., Cleveland, Toronto.)
Mail to 3012 West 106th St., Cleveland, Ohio.

☐ Send, Free, new Pneumatic Spreader Portfolio.
☐ See us about making, without obligation, an Iron Fireman Engineering SURVEY.

*Name*_____

*Address*_____

PLENTY of STEAM
is not enough!

IT MUST BE

CLEAN STEAM

to do

TODAY'S BIG JOB!

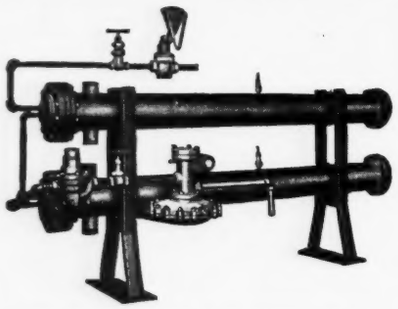
Your boilers, running at near capacity may produce enough steam—but is it clean steam—free from carryover and abrasive particles? CLEAN STEAM means—packings last longer, less cylinder oil consumption, less wear on rods and cylinders, less turbine blade erosion, no coating of turbine nozzles and blades, no sticking of reducing valves, non-return valves, traps, etc., more superheat, cleaner condenser tubes, less piston and valve leakage, less steam consumption.

Be sure of CLEAN STEAM

by installing

HENSZEY

CONTINUOUS BLOWDOWN



The Henszey system of Continuous Blowdown will rid your boiler of scale (with the proper treatment) and prevent priming, foaming, and carryover by holding the boiler water concentrations at a predetermined proper degree. The blowdown is continuously and automatically proportioned to the quantity of the make up water. This is accomplished *without heat loss!*

It will pay you to investigate the advantages of this remarkable system. Send for complete detailed information today.

HENSZEY COMPANY
Dept. D7 • Watertown, Wis.

HENSZEY

POWER PLANT SPECIALTIES

welding speeds of 40 to 80 spots per minute are obtained, depending on size of capacitor bank. *Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

Fan

SILENTVANE DESIGN 8 POSSESSES, according to maker, two characteristics which suit it to heating, ventilating and air conditioning. These are quietness of operation and low outlet velocity. Housings are made of steel plate with rolled-bead joints reinforced with heavy bracing angles. Side

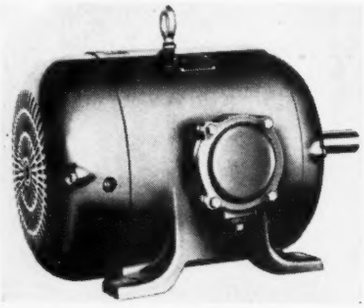
and back rotor plates are cut from heavy stock and back plate is riveted to cast-iron hub. Blades are die-formed, riveted to back plate, and welded to shrouds. In accordance with NAFM standards for Class I fans, Design 8 Silentvanes are designed for maximum tip speed of 9000 fpm. *B F Sturtevant Co, 47 Readville St, Hyde Park, Boston, Mass.*

Air Pump

STREAMLINED AIR PUMP comes with ½-hp motor, and all parts for both pressure and vacuum operation supplied. Applications include light air brushing work, including laboratory, and artists tools. Vacuum pump is rotary, operating without gears, springs or valves. *Gast Mfg Corp, Hinkley St, Benton Harbor, Mich.*

Explosion-Proof Motor

CENTURY EXPLOSION-PROOF MOTOR meets specifications and carries label of Underwriters' Laboratories, Inc, for Class I, Group D installations—where surrounding atmosphere is charged with explosive quan-



Free Watch Charm.

Jenkins Bros., New York, N. Y. Handsome miniature valve suitable for use as charm on watch chain. Sent without cost or obligation in response to penny postcard request addressed to Dept. AJ, 80 White Street, New York, N. Y.

Air Compressor Check Valve.

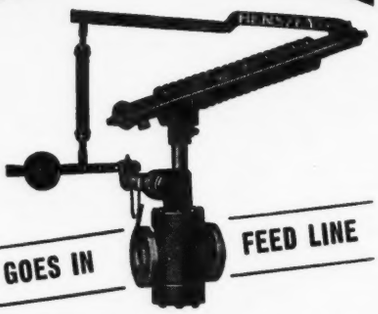
Folder 191 describes and illustrates Air Compressor Check Valve Figure 56, employing an entirely new seating principle. Folder gives facts about perhaps the most severe test ever given any valve, covering seven months of grueling service; yet Figure 56 remained bubble-tight after more than 40,000,000 pulsations. Conically shaped, light weight, stainless steel disc cleans itself on every lift-and-reseating operation; spring-loaded to cushion upstroke and accelerate downstroke for immediate closure. Large-sized cutaway view in Folder 191 permits detailed examination of new seating principle and construction. Jenkins Bros., New York, N. Y.

(advertisement)

HENSZEY

BOILER FEED

REGULATORS



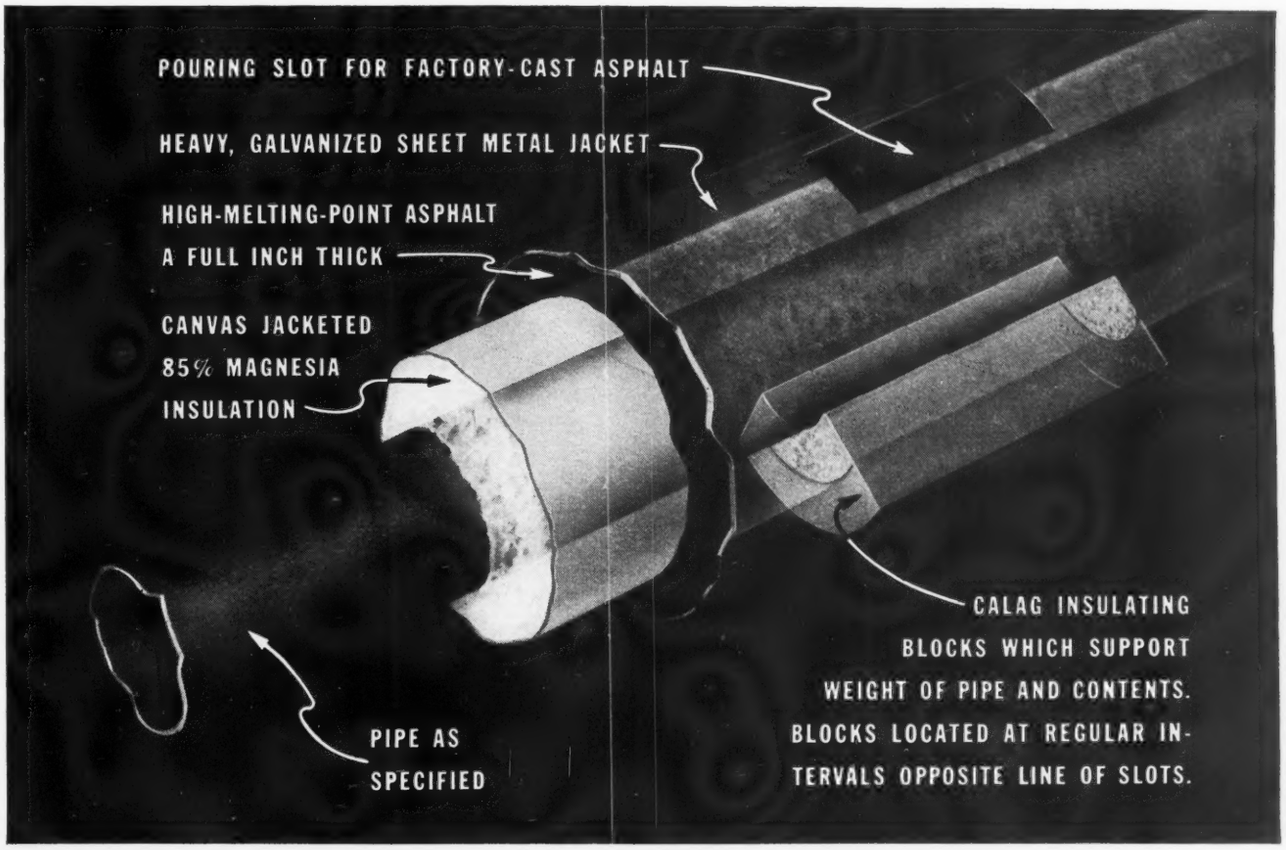
The Henszey Boiler Feed Regulator controls boiler water levels continuously and accurately under *all* load conditions!

These simple, compact, self-contained units go right in the feed line and require no additional structural support. They are as easy to install as a simple gate or globe valve. Once installed and set for operation no further attention is necessary — nothing to get out of order — nothing to reset.

Send for latest Bulletin containing full details.

HENSZEY COMPANY
Dept. D7—Watertown, Wis.

FOR UNDERGROUND PIPE LINES



10 points of Advantage... ..for Ehret's D.I.P.

Steam supply and return lines of Durant Insulated Pipe, completely installed and ready for backfill

The high insulating efficiency of 85% Magnesia with the inch-thick protecting layer of Asphalt ensures for Ehret's Durant Insulated Pipe a long and trouble-free life of service. Added to this inherent value are 10 points of advantage that make Ehret's D.I.P. outstanding for underground service.

1. **Insulation protection is absolutely dependable.**
2. **Permanently waterproof.**
3. **No sub-drains required. Complete water submersion does no harm.**
4. **Corrosion and electrolysis eliminated.**
5. **In multiple lines, individual Durant pipes can be added, removed or replaced without disturbing others.**
6. **No rollers or pipe supports required.**
7. **Tile or masonry protection not required.**
8. **Minimum trenching and field work.**
9. **No breakage or waste of material during installation.**
10. **Field costs are much lower than those of tile, tunnel and similar systems.**

Send for the Ehret D.I.P. Booklet. It gives complete information on this modern system for underground insulated piping.

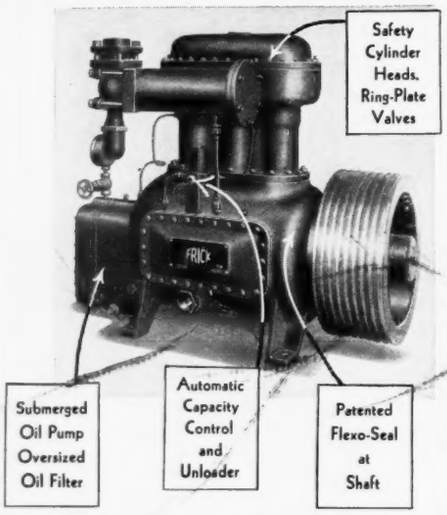
EHRET MAGNESIA MANUFACTURING COMPANY

VALLEY FORGE • PENNSYLVANIA

DISTRIBUTORS IN ALL PRINCIPAL CITIES

Distinctive Advantages Announced for the New

Eclipse Refrigerating Machines


Safety Cylinder Heads. Ring-Plate Valves
Submerged Oil Pump Oversized Oil Filter
Automatic Capacity Control and Unloader
Patented Flexo-Seal at Shaft

Don't buy ANY Freon-12 compressor until you've seen the new Frick Eclipse line! Built in three sizes, these phenomenal machines give capacities up to 60 tons refrigeration . . . in units so compact, light, efficient, and quiet they can be installed almost anywhere . . . and at a material saving over older types!

Only in the Eclipse line can you get all the exclusive advantages shown, plus such features as higher operating speeds (up to 900 r.p.m.), force-feed lubrication throughout, direct-connected motor drive when desired, pistons with 5 rings, etc., etc. Nearly 60 years' refrigerating experience built into them.

1. **Patented Flexo-Seal at Shaft.**
2. **Safety Cylinder Heads with Ring Plate Valves.**
3. **Automatic Capacity Controls and Unloaders.**
4. **Submerged Oil Pump and Over Sized Screen.**
5. **"Parallel" Operation, using Frick Oil Equalizing System.**

Write, wire or phone your Frick Branch or Distributor for full details today. Or, get in touch with

Frick Co., Waynesboro, Penna.

MASED LUBRICANT No. 177

for Bearing LUBRICATION in the HOTTEST Service Spots!

Economical, dependable maintenance of ball and roller bearing efficiency is assured at operating temperatures up to 500° Fahr.

Of a buttery consistency at room temperature, MASED LUBRICANT No. 177 defies the usual liquifying action of heat. *Give it a HOT SPOT test!* Center a piece of pea size on an electric hot plate! MASED *remains* buttery while other greases melt and run away.

MASED LUBRICANT No. 177 has a definite place in the lubrication of textile drying machinery, kiln and oven cars and innumerable types of equipment subjected to high temperature conditions.

● *Get more facts about this unusual Lubricant.*

BORNE SCRYMSER COMPANY

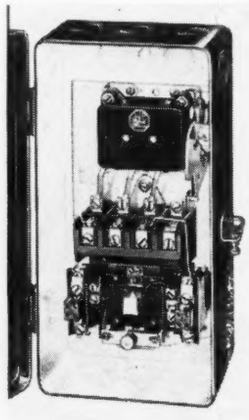
ESTABLISHED 1874

17 BATTERY PLACE • NEW YORK

tities of acetone, alcohols, gasoline, lacquer, naphtha, natural gas, petroleum, or solvent vapor. Motor is built so that it will resist pressure of an explosion of these gases, should one occur inside the motor, and not cause a similar explosion outside the motor. *Century Electric Co, St. Louis, Mo.*

Combination Starter

BULLETIN 712 STARTERS have unique handle-locking arrangement and compact high-capacity disconnect switch. Three holes for padlocks in disconnect switch permit it to be locked whenever lever is "Off". One, two, or three padlocks may be used; thus, electrician and other workers may lock switch open, and it cannot be closed until all padlocks have been removed. Disconnect-switch lever is located in front instead of side of box. Cover cannot be opened unless disconnect switch lever is "Open". *Allen-Bradley Co, 1311 S First St, Milwaukee, Wis.*



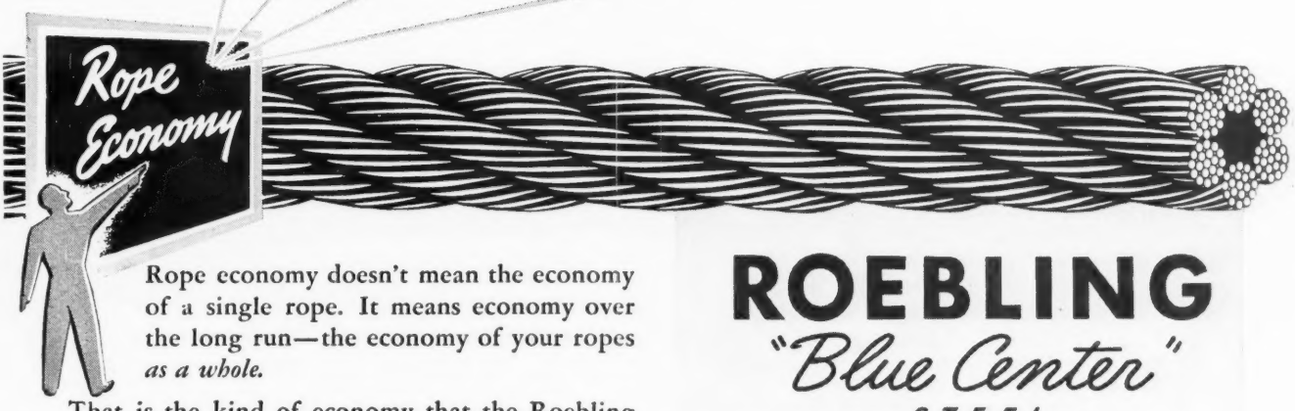
Steam Traps

ADDITIONS TO LINE OF PRESENT SIDE-INLET traps are No. 811 in 800-1000 lb per hr capacity range; No. 812, 1600-2000 lb capacity; and No. 83, 3000-4400 lb capacity. All traps feature same basic body design used by company for side inlet traps. New units built for operation on pressures up to 250 lb g, and are equipped with standard all-stainless-steel inverted-bucket operating mechanism. All are available with blast-type thermic air-vent bucket and internal-type check valves as optional equipment. *Armstrong Machine Works, 812 Maple St, Three Rivers, Mich.*

Pipe Coupling

COUPLINGS FOR PLAIN-END PIPE consist of internal sleeve surrounding two pipe ends, against which suitable gaskets are forced by means of interengaging body castings drawn together by bolts. Couplings can be used on underground pipelines, because of covered sleeve arrangement, and can be furnished with special sleeves, gaskets and bolts for special conditions. Furnished with asbestos gaskets for steam or hot-water

THE ROEBLING "4" SPELL ROPE ECONOMY



Rope economy doesn't mean the economy of a single rope. It means economy over the long run—the economy of your ropes *as a whole.*

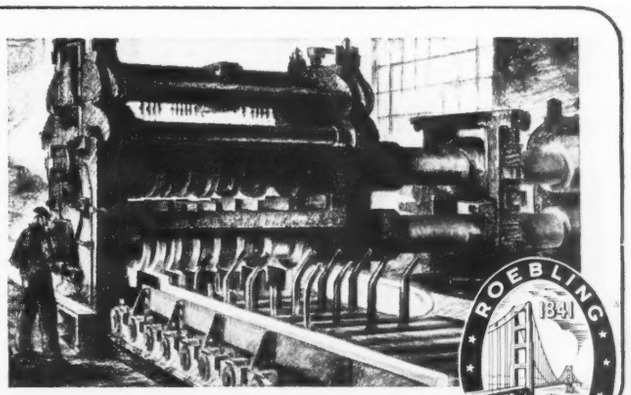
That is the kind of economy that the Roebling "4" assure in full measure. It's the economy of Roebling "Blue Center" Wire Rope—economy in terms of *overall* rope safety and minimum *general average* rope operating cost.

ROEBLING *"Blue Center"* STEEL WIRE ROPE

"TAILOR-MADE" STEEL MAKES A BIG DIFFERENCE!

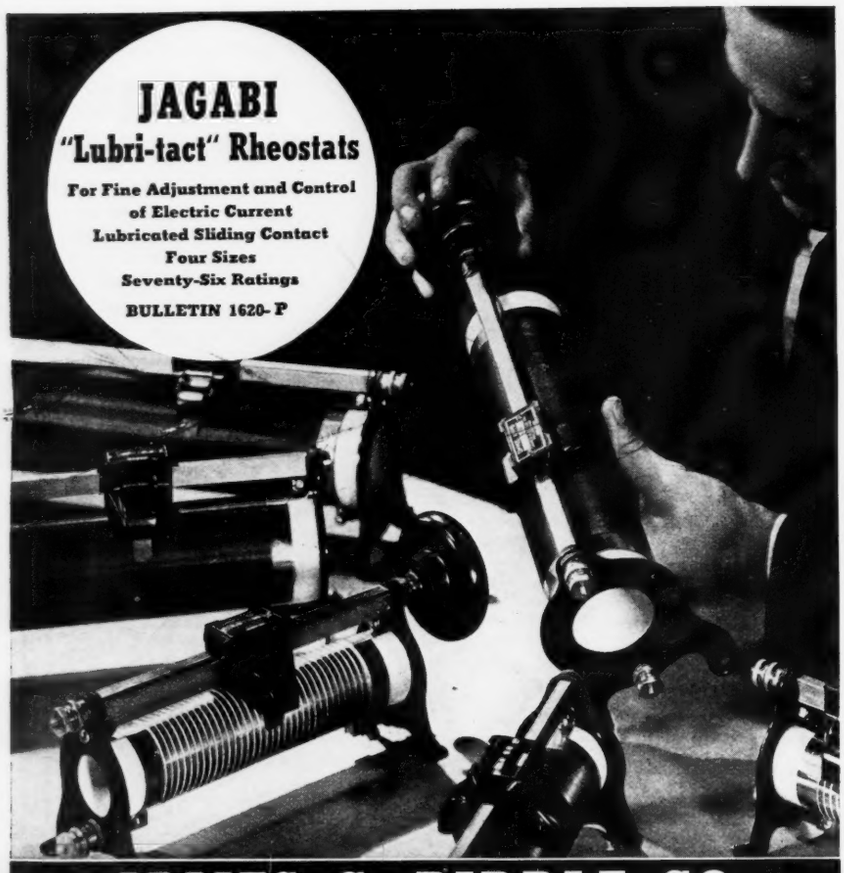
Roebling "Blue Center" quality starts right with the steel. We make our own—in special open hearth furnaces—because that's the only way we can guarantee the extra toughness and stamina that "Blue Center" steel must have.

100 years of experience. Painstaking care. Control of every process from steel making to final testing. These are some of the important factors that count so heavily in Roebling rope service.



JOHN A. ROEBLING'S SONS COMPANY TRENTON NEW JERSEY

Branches in Principal Cities Export Division: 19 Rector St., New York, N.Y., U.S.A. Cable Address: "Roebling's", New York



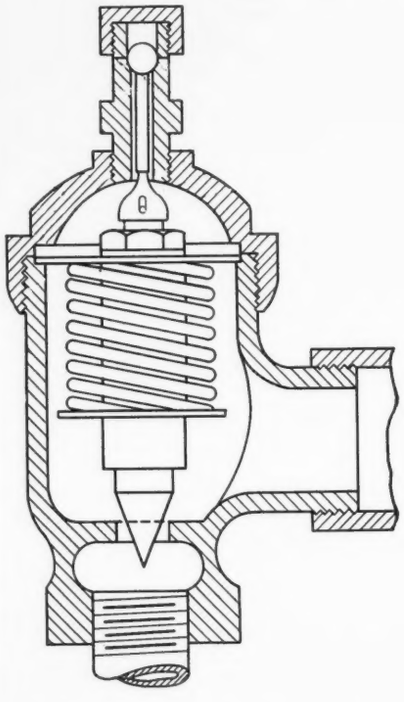
DIXON'S
Flake Graphite
DIXON'S MICROFYNE Flake GRAPHITE
GRAPHITE EXCELLENCE SINCE 1827
SOME WARS NEVER END
In the everlasting war of lubrication vs. friction, you can't beat veteran Ticonderoga Flake Lubricating Graphite. Used alone or mixed with oils and greases, these pure, slippery flakes impregnate wearing surfaces with an unctuous film that defies heat, cold, pressure and solvents. Ticonderoga coated gaskets make tight joints yet can be removed without sticking. Packing coated with this fine old product can be set up tight without building up friction.
Particle Size No. 1—large, lubricious flakes.
Particle Size No. 2—powdered flakes.
No. 635—Minutely subdivided powdered flakes for close tolerance applications.
Microfyne—Processed to microscopically subdivided particle size for closest tolerances.
ALSO PROFIT BY USING THESE
From your Supply house or write for Literature C-94.
GRAPH-AIR GUNS
10¢
DRY GRAPHITE LUBRICATION FOR LOCKS AND A 1000 OTHER USES—
SQUEEZE 'EM
INSOLUBLE IN WATER
DIXON'S PIPE JOINT COMPOUND
DIXON'S CUP GREASE
DIXON'S Belt Dressing
JOSEPH DIXON CRUCIBLE CO.
JERSEY CITY, NEW JERSEY

374

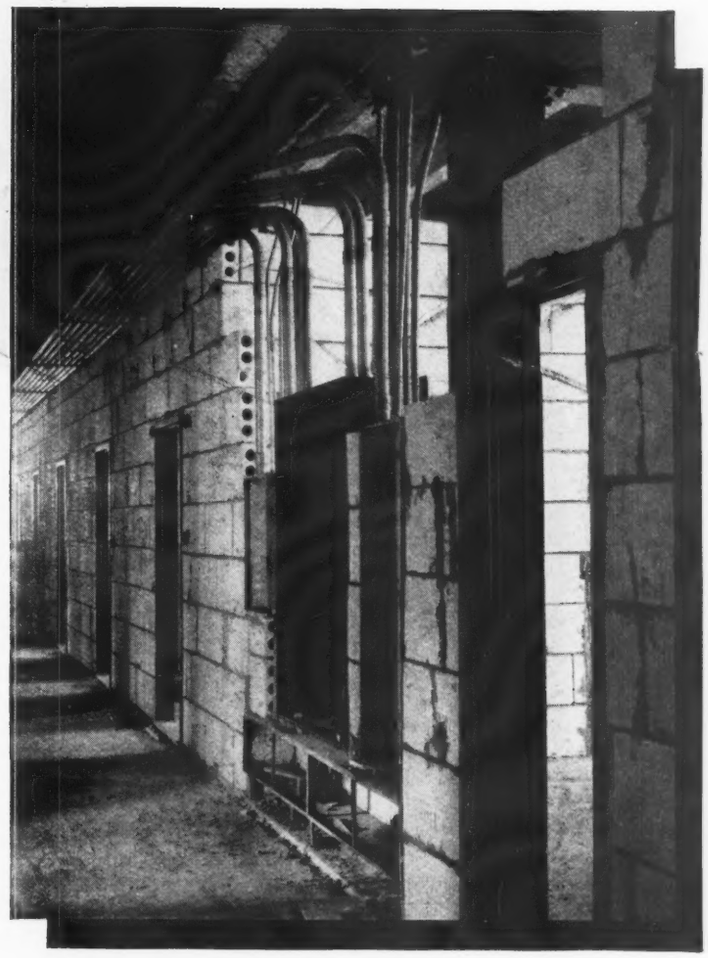
lines, and can be used as expansion joints. *Regor Products Co, 333 Kearny St, San Francisco, Calif.*

Vacuum Trap

SELF-VENTING VACUUM TRAP has following features: will heat radiator immediately, eliminates and prevents back pressure in return line, prevents radiator from becoming air bound. locates defective element, makes radiator and system noiseless, prevents knocking and cuts fuel costs. When defective element is collapsed, steam condenses in air vent, causing hissing sound,



and providing warning. Element is so constructed as to have two opposed seats. At a desired temperature it will close seat of air vent to return line, and seat itself simultaneously. Air vent is constructed without working parts, such as thermostat, but simply a passageway with ball to seat, thus causing vacuum to exist when air is not passing through. Vent allows air in radiator to pass through instead of going into return line. *K & M Heating Specialties Co, Empire State Bldg, New York, N. Y.*



Battelle and Buckeye

TWO DISTINGUISHED NAMES

Among men of industry, the Battelle Memorial Institute stands high for achievement in scientific research and materials development.

With electrical contractors, the name Buckeye signifies first quality and top performance in electrical conduit.

It is no mere coincidence that Buckeye Conduit was selected for the recently completed addition to the beautiful Battelle building in Columbus. For Buckeye is the largest selling conduit in America, as well as the finest.

Made as an important specialty by Youngstown, Buckeye Conduit is fabricated of materials quality-controlled and quality-guarded throughout every operation to the finished product, on machines that are the last word in efficiency, by men whose long years of experience have made them artists of perfection. MATERIALS, MEN and MACHINES - they bring you Buckeye -- most reliable rigid steel electrical conduit, easy to handle, easy to bend, ideal for close work and affording complete protection to your wiring. 26-19D

This installation of 2" Buckeye Conduit in the new addition to the Experimental Laboratories of the Battelle Memorial Institute at Columbus, Ohio, is an exceptionally fine example of close work and bending. Supplied by Pixley Electric Supply Company, the conduit was installed by the Weisz Electric Company of Columbus.

BUCKEYE TRADE MARK YOUNGSTOWN CONDUIT

YOUNGSTOWN

Manufacturers of Carbon, Alloy and Yoloy Steels

★

THE YOUNGSTOWN SHEET AND TUBE COMPANY, General Offices, YOUNGSTOWN, OHIO

Conduit - Sheets - Plates - Bars - Rods - Wire - Nails - Tin
Plate - Pipe and Tubular Products - Tie Plates and Spikes

COCHRANE

The EAGLE'S EYES *are* PLEXIGLAS

PLEXIGLAS is an acrylic plastic manufactured by Rohm & Haas Co., Bristol, Pa., and used in the nose, observation hatches, gun turrets, etc., in bombers and other aircraft. It is more transparent than glass, and is impervious to the effect of sunlight and extremes of heat, humidity, etc. In its manufacture, one of the essentials is

CLEAN, HOT, DRY STEAM
insured by the use of
Cochrane
SEPARATORS

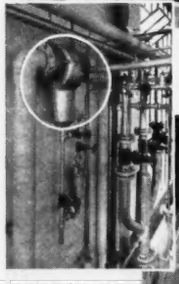
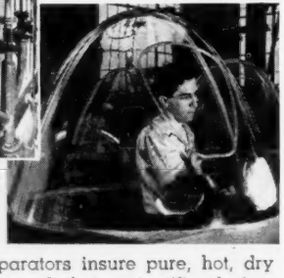


Fig. 118 Cochrane All-Service Separator on process steam line in plant of Rohm & Haas Co.



(Right) Bomber nose of Plexiglas being buffed and polished.

Cochrane Separators insure pure, hot, dry steam because of their scientific design. Purified steam cannot contact the entrainment because steam flow is guided away from drip area. Baffle area extends far outside jet of steam from inlet pipe. Write for Publication 2725.

COCHRANE CORPORATION
3106 N. 17th STREET • PHILADELPHIA, PA.

COCHRANE

Heat-Transfer Machine

(Continued from page 78)

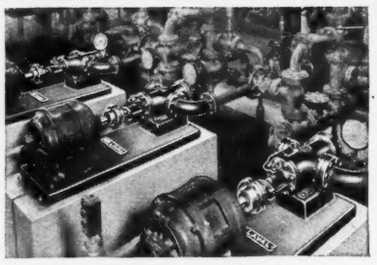
trically plotted curves almost exactly reproduced those laboriously obtained with thermocouples buried in the actual cork insulation. In a few minutes the electrical solution reproduced days of experimental work.

The problems explained so far have been handled as cases of heat flow in a single dimension. For 3-dimensional thermal problems the body must be broken down into a series of pieces, each of three dimensions. Each such piece may be a cube (Fig. 4) or any other convenient shape. If the shape is a cube and the material is homogeneous, its heat resistance is the same along the three intersecting resistances. To their center point is connected a condenser whose capacity is equal to the heat capacity of the piece. We then have the complete electrical counterpart of the heat properties of the piece. Such electrical counterparts can then be connected to simulate the entire body to be "tested."

So far, in this discussion, it has been implied that a temperature difference of 1000 F would be represented by 1000 volts, a heat capacity of 50 Btu per degree F by 50 Farads, a heat-flow time of one hour by one second of electrical flow, one Btu by one Coulomb of electrical charge and one Btu per hour by one ampere. Obviously such one-to-one ratios might involve electrical and time values not convenient for laboratory testing. As a matter of fact the electrical values used in actual testing are juggled considerably for the sake of convenience. This introduces no error if certain relations are maintained and proper conversion factors are used. The mathematical method is explained in the ASME paper compiled by Messrs Paschkis and Baker.

The machine or apparatus (Dr Paschkis calls it the "model") shown in the photographs differ greatly from the original apparatus of Beuken of Holland. Most important improvements are arrangements for changing the capacity during the experiments and for automatically recording the voltages.

The equipment is in fifteen sections, each of which may represent one section of the original heat-transfer structure. Each section has six trays of condensers ranging in capacity from 0.1 microfarad to 20 microfarad. In any section it is possible to plug in any capacity from 0.1 microfarad to 152



3 IMOs in fuel oil burner service; 43 g.p.m. each against 300 lb. per sq. in.

IMO holds a steady oil pressure

The three rotors of the De Laval-IMO oil pump propel the oil forward uniformly, as would a piston moving always in one direction. The fact that there is no pulsation is valuable in oil burner, lubrication or hydraulic pressure service.

The three moving parts are in perfect rotational and hydraulic balance, and the pump can be coupled to a standard speed motor or turbine. There are no valves, separate bearings or timing gears.

Write for Catalog I-80.

IMO meant I MOVE OIL

IMO PUMP DIVISION
of the
De Laval Steam Turbine Co.
Trenton, New Jersey

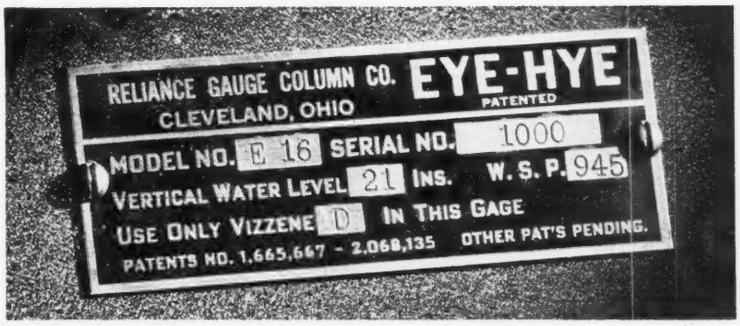
ACCURACY
GUARANTEED, WITHIN 1%

all-metal THERMOMETER construction insures LONG-TERM DEPENDABILITY, TOO!

To the virtue of high initial accuracy at every point on the scale, WESTON Thermometers also add the ability to *maintain* that accuracy over long periods. » » » This *long* dependability stems from WESTON'S *simple* and *proved* temperature indicating principle, which employs only *enduring* all-metal construction.

To the many users of WESTONS throughout the process industries, this long dependability has meant better protection and control of important processes, as well as the elimination of frequent thermometer replacements and repairs. Thus they are *cutting costs, all around!* Booklet containing complete information gladly sent on request. Weston Electrical Instrument Corporation, 679 Frelinghuysen Avenue, Newark, N. J.

WESTON ALL-METAL GAUGE TYPE **THERMOMETERS**


RELIANCE GAUGE COLUMN CO.
CLEVELAND, OHIO
EYE-HYE
PATENTED
MODEL NO. E 16 SERIAL NO. 1000
VERTICAL WATER LEVEL 21 INS. W. S. P. 945
USE ONLY VIZZENE D IN THIS GAGE
PATENTS NO. 1,665,667 - 2,068,135 OTHER PAT'S PENDING.

1000th EYE-HYE SHIPPED

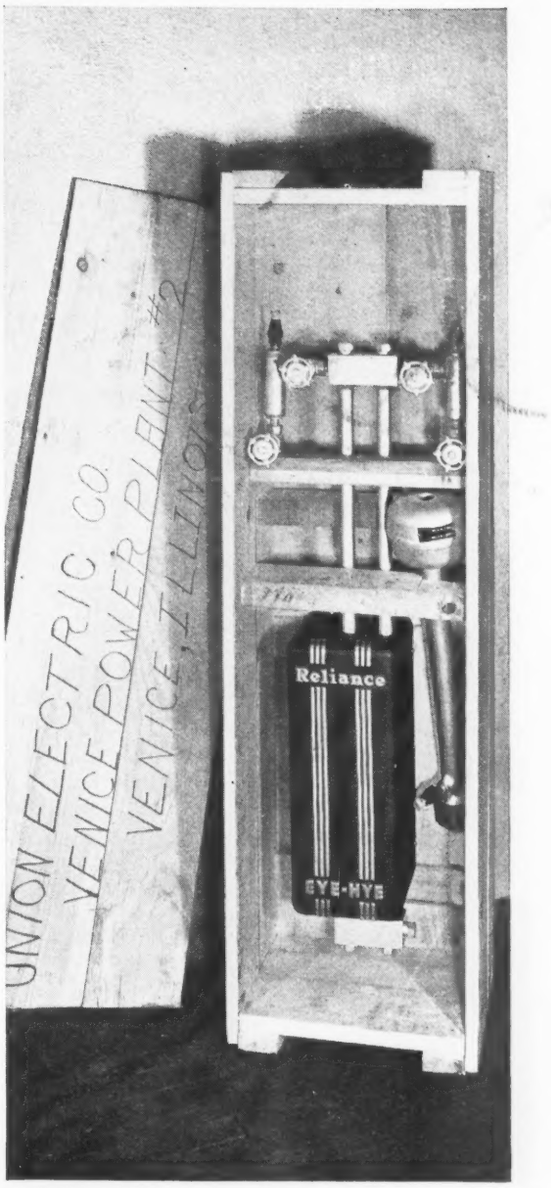
New Remote-Reading Reliance Water Gage Adds Safety to Boilers Everywhere. Prominent Mid-West Utility Gets EYE-HYE No. 1000

YOU power engineers welcomed EYE-HYE four years ago as a safer, more convenient water level gage — a device that for the first time brought an accurate hydrostatic manometer type gage down to eye level, any place in the boiler room or to control station many feet away, regardless of obstructions • Now Reliance ships EYE-HYE No. 1000. It goes to "Venice No. 2" plant of the Union Electric Co., at Venice, Ill., with three other EYE-HYEs destined for use on the 945 lb. boilers being installed. They are to provide the constantly accurate SIGHT check for efficient water level supervision • The hundreds of engineers who have installed EYE-HYE enjoy new freedom from water level worries — take pride in this new modern efficiency added to their controls • Write today for EYE-HYE Bulletin 382, and Bulletin 416 which shows the "Blue Book" list of EYE-HYE users.

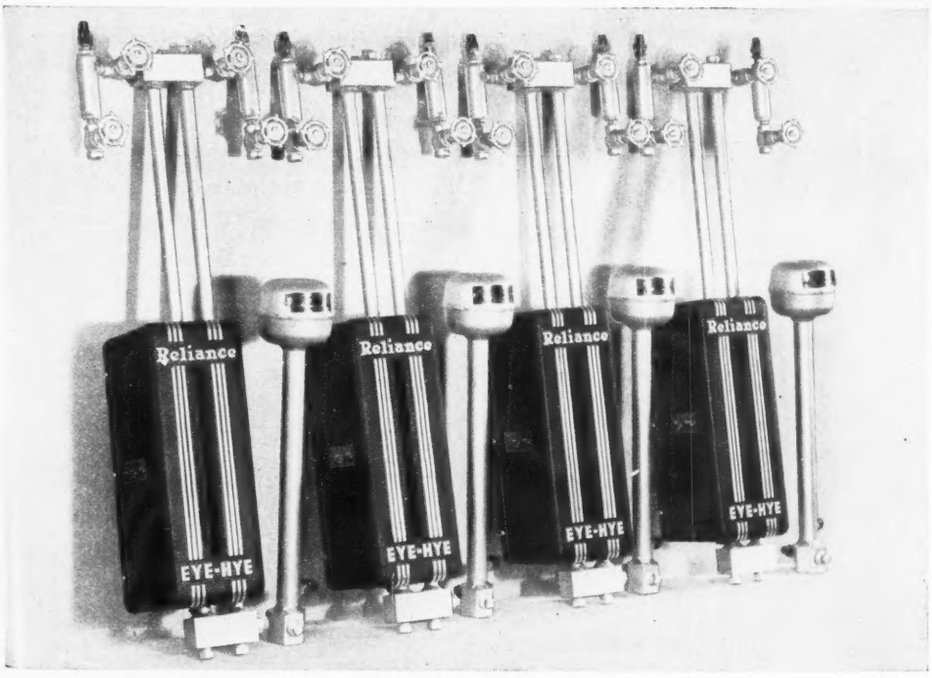
THE RELIANCE GAUGE COLUMN CO., 5902 Carnegie Ave., Cleveland, Ohio

Boiler Safety Devices since 1884

Reliance



EYE-HYE Serial No. 1000 boxed for shipment to Union Electric Co., Venice (Ill.) No. 2 plant, with its accompanying Unitemp — the patented temperature equalizing, actuating element for the EYE-HYE.



★ ★ ★

All 4 of these EYE-HYEs are for "Venice No. 2.". . . It's no trouble to install EYE-HYE on old or new boilers. And it can be placed below or above the drums, or in a separate control room. Nothing stops the EYE-HYE connecting tubes — pipes, girders, equipment or walls.

EYE-HYE operates day after day without trouble, practically without expense. Shows exact reading in a brilliant illuminated column — can be seen many feet away. Made for all pressures.

MAXIM
SILENCERS

KILL
NIGHT SHIFT NOISE

Today more and more plants are operating on increased production schedules . . . schedules often calling for 24 hour operation.

The night shift is with us again, and plants in semi-residential districts find the noise problem acute. If you have this problem (from exhaust or intake noises) call in MAXIM . . . SILENCING SPECIALISTS FOR 25 YEARS.

SEND COUPON
FOR DETAILS

THE MAXIM SILENCER COMPANY
92 Homestead Ave., Hartford, Conn.

Please send details on your Compressor Exhaust Steam Silencers.

Name .....

Company .....

Address .....

City ..... State .....

microfarad by steps of 0.1. All these condensers are accurate to within plus or minus one percent and the insulation resistance is at least 15,000 megohms per microfarad to prevent appreciable loss of charge from the condensers during the period of a test. There are 525 condensers in the entire apparatus.

Fig. 5 shows the electrical connections of one of the 15 sections. Circles represent plug holes for jack connections. At upper left note the six trays of condensers, one side of each grounded. On resistor board at right is set up the electrical resistance for the section, anything from 100 ohms to 1,111,000 ohms. At lower left and center are shown the plug-board and switchboard of the section, through which the condensers can be properly connected to the resistances and the whole to the other sections.

The condensers may be combined into six groups by plugging from the flexible plugboards on the trays to the busboard. It is also possible to connect condensers of one section to the bus board of another. Ten busses run along the top of the installation of resistor and condenser sections, so that any of the instruments may be plugged to any of the sections. For the 15 sections several thousand plug connections are available.

Power controls and the instruments are mounted on a central panel. A special unit plugged in on the local 110-volt a-c current delivers constant-voltage d-c at any desired potential from 286 volts down, so that voltage may be set up corresponding to the temperature difference under consideration.

If desired, the equipment may be set for automatically controlled constant-current flow rather than for constant voltage, thus simulating the condition of constant heat flow with varying temperature difference. Specially developed electronic voltmeters are used to measure the potential (corresponding to temperature) in the various sections—also an electronic ampere-minute meter which measures charge in coulombs (corresponding to heat in Btu).

While interesting, these details are of less interest than the fact that there is now available in America a machine that can quickly solve almost any problem of the flow of heat in solid materials, however complex the shape or irregular the heating conditions. It should find useful application in the following fields, among others: Refrigeration, quick freezing, welding, heat insulation, furnace walls, electric heating, process work, building walls, in

BATESGRATES
FILLET WELD
Open Steel Floor Grating

Easily maintained - - -
NO CRACKS, JOINTS, CREVICES

Batesgrates are self-cleaning because of peaked, non-skid cross bar. They have no grooves or rough burned metal to catch grease or dirt. Safe traction. Batesgrates are strictly one piece — no cuts, slots, or punching. Made from Hexagon Shaped Hot Rolled Steel Bars with smoother, larger, much stronger welds. Send today for engineering Catalog No. 937.

When you need grates
SPECIFY BATES
for long-time economy

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208 S. LaSalle St. Chicago, Ill.

HERCULES
Seamless Copper
FLOATS

GUARANTEED
TO STAND UP!

Every Hercules Float carries our guarantee to stand up under 350 lbs. working pressure and 500 degrees temperature.

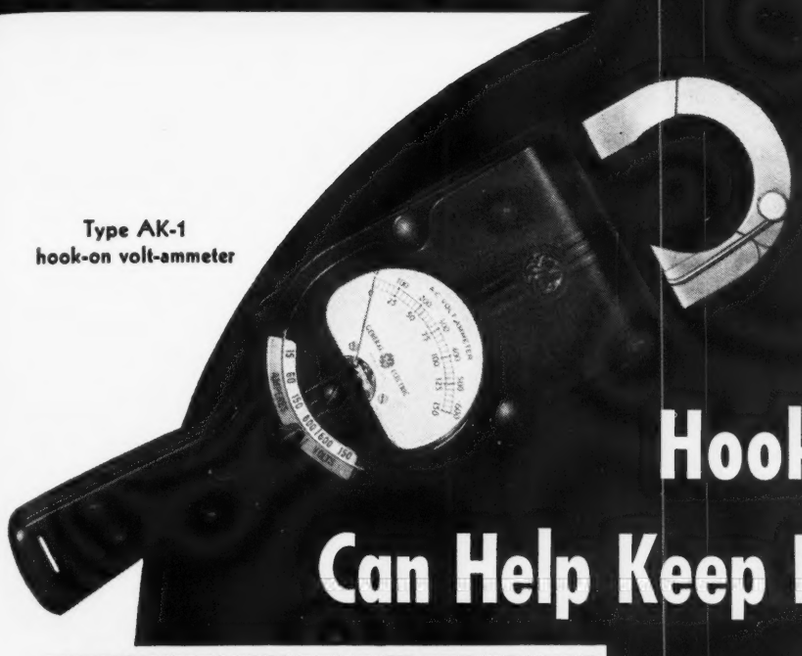
Fabricated of seamless copper under our special spinning process. Hercules Floats are uniform in thickness and high in mechanical strength.

You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.

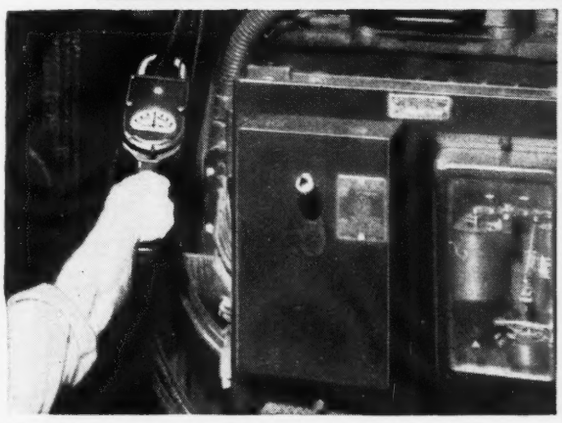
Insure care-free maintenance of water level in your heaters, tanks, reservoirs and other equipment by specifying "HERCULES."

HERCULES FLOAT WORKS
200 Franklin St.
SPRINGFIELD, MASS.

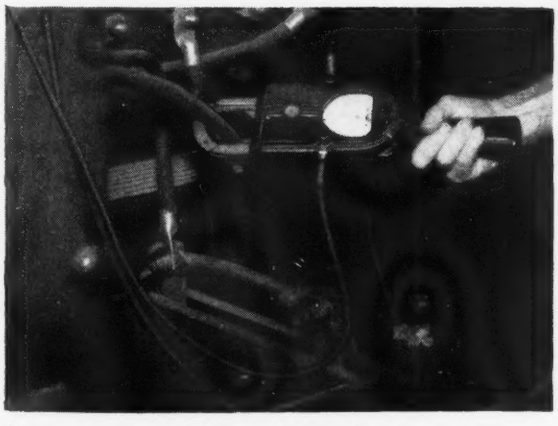
Type AK-1
hook-on volt-ammeter



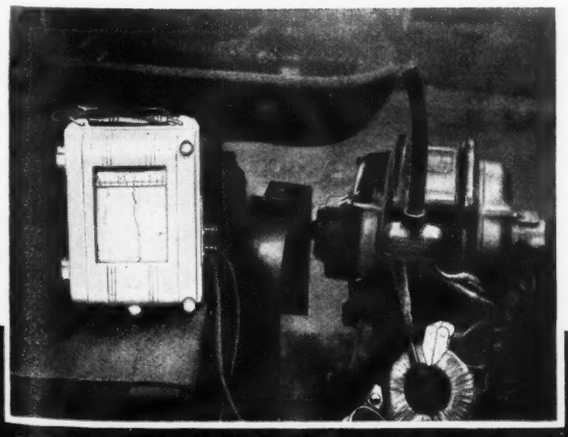
How These Hook-on Instruments Can Help Keep Production Rolling



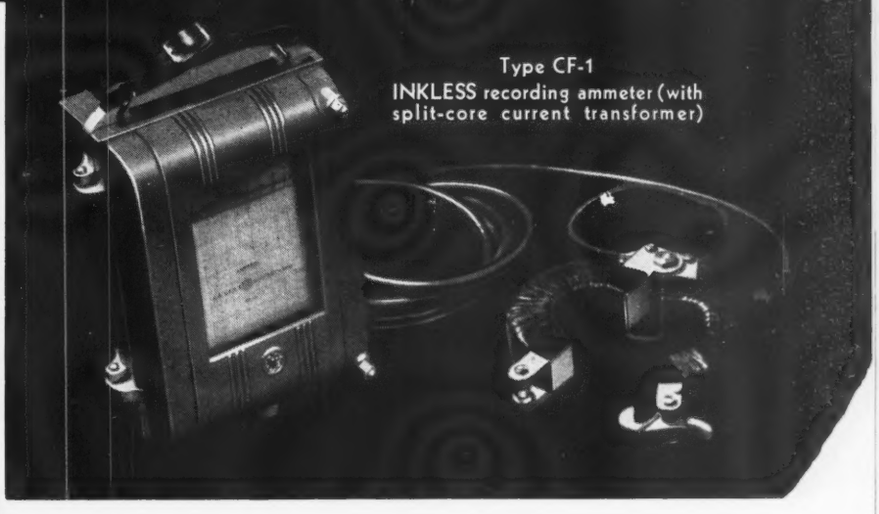
The AK-1 is made for tight places. Here it is being used for a quick, easy measurement of voltage-regulator current.



Measuring a-c VOLTS and AMPS. Hook it around a conductor to measure amperes. Connect the voltage leads (as shown above) to measure volts. With this one setup, you can make either measurement just by flicking the selector switch.



Checking motor load with the CF-1 recording ammeter and split-core current transformer.



Type CF-1
INKLESS recording ammeter (with split-core current transformer)

1. The ease of making tests encourages routine testing and promotes good maintenance, which prevents production delays.

2. Emergency tests can be made without cutting conductors—thus avoiding shutdowns.

TODAY, when motors and other electric equipment are being taxed to the limit and may be overloaded, frequent testing of circuit conditions will often avert serious production delays. These instruments will take care of almost all your testing work.

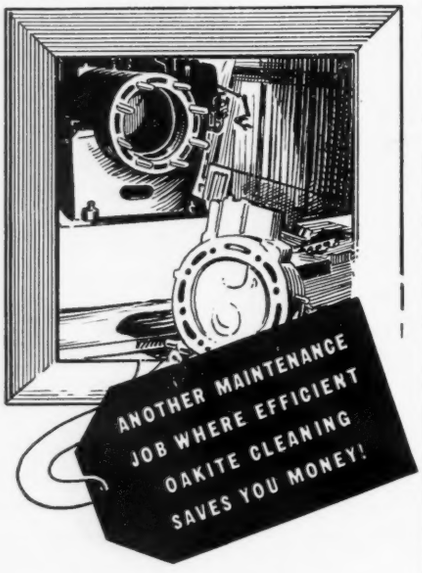
The volt-ammeter is ideal for emergency tests where a fast check of circuit conditions is needed. It measures both VOLTS and AMPERES. Having six a-c ranges, it's really six instruments in one —0-15/60/150/600 amperes and 0-150/600 volts.

The INKLESS feature of the recording ammeter makes it the handiest of recorders for general plant maintenance. With no pen to start and no inkwell to fill, it's ready to be hooked around a conductor and start recording at a moment's notice.

You're overlooking a good bet if you don't have both these handy G-E instruments for emergency and maintenance testing. For complete information on the volt-ammeter, ask for Bulletin GEA-2950; on the recorder, GEA-3187. Your G-E office has copies. General Electric, Schenectady, New York.

GENERAL ELECTRIC

Are Your Compressor Jackets Clogged With Scale?



To completely remove lime-scale and rust accumulations from water jackets of your air and gas compressors, take this profitable tip . . .

Fill jackets with recommended solution of Oakite Compound No. 32 . . . let "soak" for short period . . . then rinse as directed. That's all! For you will find the superior, vigorous de-scaling action of this specially designed, SAFE material speedily removes insulating deposits. Yes . . . it helps restore full heat transfer efficiency, so that your compressors again operate practically like new. The cost? Surprisingly low!

YOUR COPY IS FREE!
This 20-page booklet gives concise data on safely de-scaling such other equipment as Diesel cooling systems, "lube" oil coolers, feedwater heaters, surface condensers, evaporators. Profit from the money-saving facts it contains by writing for your FREE copy today!

OAKITE PRODUCTS, INC.
23 Thames Street, New York, N. Y.
Representatives in All Principal Cities of the United States and Canada.

OAKITE *Certified cleaning*
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

ternal-combustion engines (pistons, walls, jackets), foundry work, ingot casting, billet heating and so on.

The only limitation on the type of problem that can be solved seems to be the size of the electrical machine. Having fifteen sections at present, it can be used to duplicate any heat-transfer structure that can be suitably represented by fifteen divisions. If the shape is so irregular that more than fifteen are needed for a suitably accurate solution, it will normally be necessary to enlarge the apparatus by adding equipment.

Power Lines

(Continued from page 122)

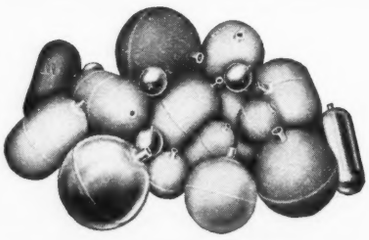
appointed chief engineer, a position he has held since. In 1940 he was awarded a plaque by the National Association of Manufacturers as a modern pioneer in American industry.

WILLIAM A MARSTELLER has been appointed advertising and sales promotion manager by Edward Valve & Mfg Co, East Chicago, Ind. He has had many years of newspaper, advertising and sales experience in Champaign and Chicago, Ill.

PROFESSOR FRANK O ELLENWOOD, head of the department of heat-power engineering in the Sibley School of Mechanical Engineering, was appointed to the John E Sweet professorship in Mechanical Engineering at Cornell University. Professor Ellenwood has been a member of the engineering faculty at Cornell since 1911, when he came to the University as assistant professor of heat-power engineering. He was made professor in 1915 and head of the department in 1940.

LAURENCE M EWELL has been appointed general manager of eastern division operations and CARL WOERWAG was made New York City office manager of the Link-Belt Co, Chicago. Mr Ewell, a graduate of the Link-Belt engineering department, entered the employ of the company in 1906 and advanced through the drafting and estimating departments. Since 1915 he has been associated constantly with the sales department, as a sales engineer and manager of various branch offices. Mr Woerwag joined the company in 1910 in the drafting room, and held several posts, including squad engineer and sales engineer in the export department. He has since made trips

NICHOLSON



HIGH-PRESSURE WELDED FLOATS

Available for all applications—for steam pressures up to 1500 lbs. and hydrostatic pressures up to 2500 lbs.—for corrosive and non-corrosive service.

Made in spherical and eliptical shapes and in sizes from 2½" to 14" diameter. High in tensile strength and offer great resistance to external pressure. Special sizes and shapes available to order, and also cadmium, nickel or copper plated. Fully described in Bulletin No. 339.

OTHER PRODUCTS — NICHOLSON Industrial Steam Traps, Piston and Weight Operated Traps, Flexible Couplings, Expanding Mandrels, Arbor Presses, Compression Shaft Couplings, Steam Eliminators and Separators, Compressed Air Traps.

W. H. NICHOLSON & COMPANY
125 OREGON STREET
WILKES-BARRE PENNSYLVANIA, U.S.A.

Speed ✓ *Production* ✓ BUT DON'T FORGET SAFETY!

POSITIVE PROTECTION
for pressures from 400 to 5000 lbs. — MODEL HRV HYDRAULIC RELIEF VALVE

Bronze—of a very high grade special composition. Outlet connection in base casting so that, in regrinding, valve seat and outlet piping need not be disconnected. Six sizes; three pressure ranges. *Write J. E. LONERGAN COMPANY, Race and Second Sts., Philadelphia, Pa., for complete catalog of precision*

VALVES • GAUGES • SPECIALTIES

Lonergan

300 SPECIALTIES for POWER PLANTS—SINCE 1872

CLEAN STEAM

(4/10 PARTS PER 1,000,000)

PRODUCED BY A

W-K-M "MASTER" SCRUBBER

AT A VELOCITY OF 20,000 FT. PER MIN. IN THE PLANT OF A LARGE PUBLIC UTILITY COMPANY, CHECKING OUR GUARANTEE OF "STEAM EQUAL IN CLEANLINESS TO TRIPLE DISTILLED WATER".

(Further information on request)

EQUAL RESULTS ON COMPRESSED AIR AND GAS

BRADSHAW & CO., 530 Fourth Ave., Pittsburgh, Pa.

Gentlemen: Without obligation, you may send me the bulletin fully describing the W.K.M. Master Scrubber, for:

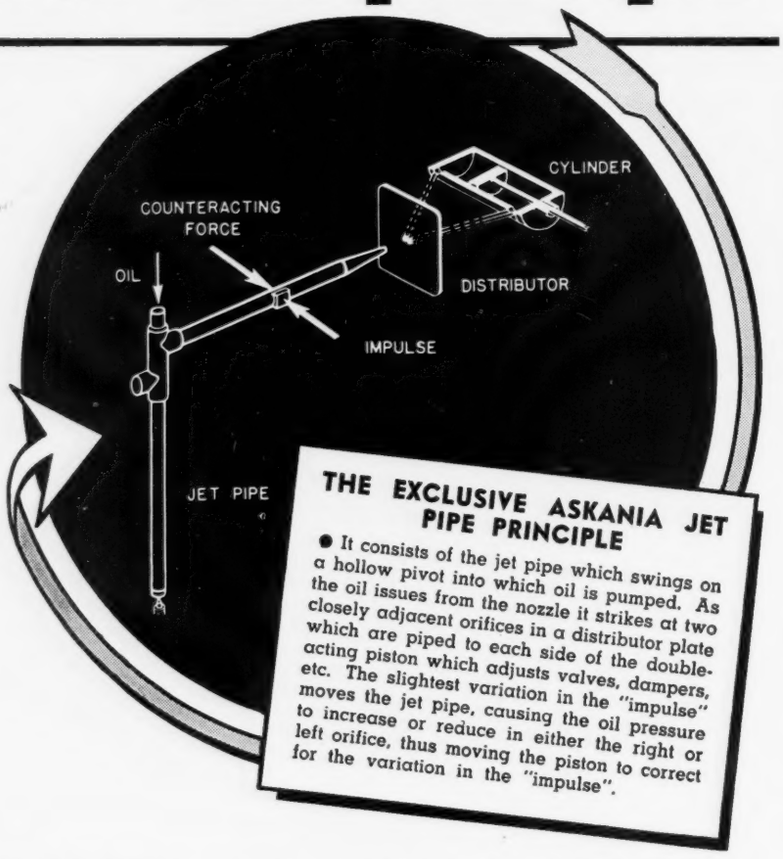
STEAM GAS AIR

Name Company Address City State

(PLEASE PRINT)

11

Only ASKANIA has this principle



THE EXCLUSIVE ASKANIA JET PIPE PRINCIPLE

● It consists of the jet pipe which swings on a hollow pivot into which oil is pumped. As the oil issues from the nozzle it strikes at two closely adjacent orifices in a distributor plate which are piped to each side of the double-acting piston which adjusts valves, dampers, etc. The slightest variation in the "impulse" moves the jet pipe, causing the oil pressure to increase or reduce in either the right or left orifice, thus moving the piston to correct for the variation in the "impulse".

OBSERVE this jet pipe principle carefully—for it is the gateway to greater sensitivity of control with greater stability, greater dependability and lower maintenance cost than can be achieved in any other way.

The Askania control system uses oil as the operating medium and consequently every part literally "runs in oil". Since oil is incompressible, every adjustment has the power and certainty of hydraulic operation.

Scores of users have praised this certainty of operation. As one user phrases it "We like the way the control maintains its adjustment day after day—this helps to maintain highest possible operating efficiency."

The jet pipe offers the most simple and direct solution for combustion control problems. Let us explain this exclusive principle in terms of *your* plant conditions.

ASKANIA REGULATOR COMPANY

Corner 16th Street and Michigan Avenue, Chicago, Ill.

ASKANIA *Combustion* CONTROL

to all parts of the world, studying the work of the company in other countries.

H V Erben, assistant manager of General Electric's Central Station Dept since 1939, has been made manager of that department. A native of Schenectady, Mr Erben is a graduate of Yale Sheffield Scientific School as a mechanical engineer. He first became associated with General Electric in 1917,

H V Erben

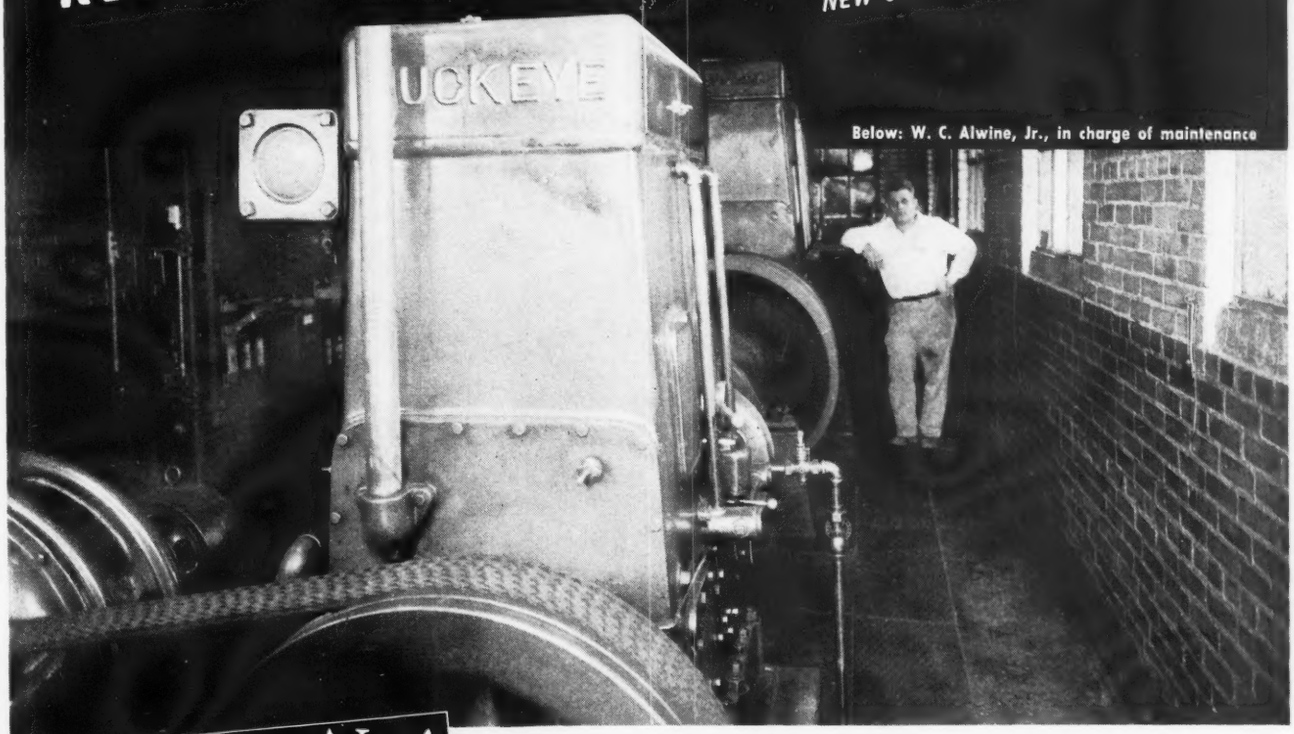
but soon left to be second lieutenant in the field artillery. Reentering the company in 1920, he was in the testing department at the Schenectady and Pittsfield works. In 1922 he was transferred to the Lighting Engineering Dept. and in 1923 made section head of the apparatus division of the reorganized Central Station Div.

McQuay, Inc. announces appointment of O H Halberg as representative for New York City, Brooklyn, Staten Island, and Long Island.

Tom Marsh has been made national industrial engineer for Iron Fireman Mfg Co. at Cleveland, Ohio, plant. He was formerly in Chicago as central division engineer for the company. Since joining Iron Fireman in 1934, Mr Marsh has been active on the executive committee of the Fuels Div of the ASME, on the model smoke ordinance committee, and on the fuel-testing committee. He is also author of the texts,

Tom Marsh

BELIEVE IT OR NOT!*—
"50 HOURS PER WEEK FOR 3 YEARS . . .
NEVER A RING JOB SINCE USING RING-FREE"
—SAYS ALWINE BRICK COMPANY
NEW OXFORD, PA.



Below: W. C. Alwine, Jr., in charge of maintenance

Believe It or Not!
by Ripley
WHEN A 16-INCH U.S. COAST DEFENSE GUN IS FIRED— THE ENERGY RELEASED BY THE CHARGE IS EQUAL TO THE POTENTIAL ENERGY IN 18 GALLONS OF GASOLINE!
IMAGINE THIS TREMENDOUS ENERGY RELEASED INSIDE YOUR MOTOR! NO WONDER MOTORS WEAR OUT! THAT'S WHY YOUR CAR NEEDS AN OIL THAT REDUCES FRICTION FAST. THAT'S WHY MACMILLAN RING-FREE IS THE MOST-TALKED-ABOUT MOTOR OIL IN AMERICA TODAY. IT IS AMERICA'S No. 1 FRICTION-FIGHTER! IT—
REDUCES MOTOR WEAR AND REPAIR
ADDS HP.* MORE HORSEPOWER
GIVES UP TO MORE MILES PER GALLON OF GAS AND — BELIEVE IT OR NOT! — IT ACTUALLY REMOVES CARBON WHILE IT'S DOING THE JOB YOU PAY FOR:
THOROUGH LUBRICATION!
* AVERAGE SPEED ON 1000 CERTIFIED ROAD TESTS

—as drawn by Ripley in Life, Collier's, Time

"Three years ago when we installed two (2) Buckeye Diesel Engines, one 40 HP and one 187½ HP, we used a nationally advertised lube oil of high reputation. After a few months we began to lose power, in the small engine especially, because it was constantly running with a slight overload. We finally pulled the pistons and found the rings badly stuck. At about the same time Macmillan Ring-Free Oil was introduced to us. After a little while the large engine was restored to its original performance without having to spend one penny on it. Up to the present time we have done no work on this engine. We believe we will continue operating this engine at least another year or two before a ring job is necessary. We operate this engine about 50 hours per week." But see for yourself how Ring-Free removes carbon and saves repair. Call the Macmillan Man for proof.

MACMILLAN
RING-FREE
MOTOR OIL

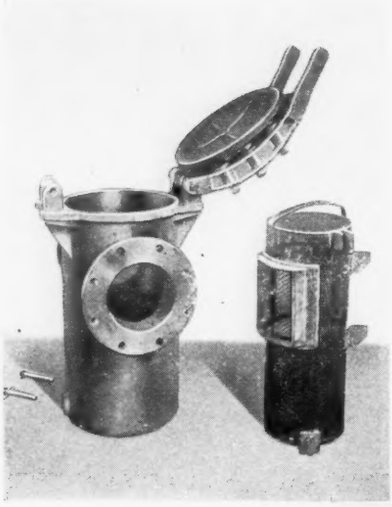
MACMILLAN PETROLEUM CORPORATION
50 WEST 50TH STREET, NEW YORK • 624 SOUTH MICHIGAN AVENUE, CHICAGO • 530 WEST 6TH STREET, LOS ANGELES

*Reg. U. S. Patent Office

Copyright 1941 by Macmillan Petroleum Corporation

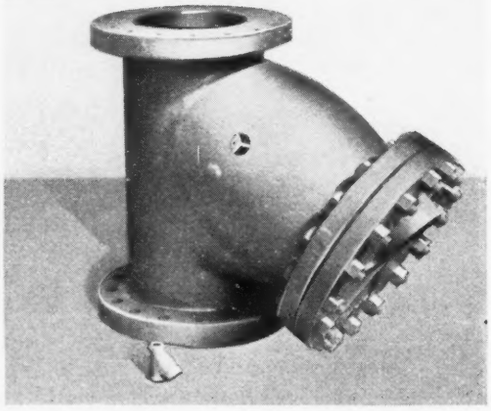
ADVERTISING PAGES REMOVED

Precision Built



for POSITIVE PROTECTION

Above — Davis No. 77 Strainer. Flow is straight into basket without change of direction—negligible pressure drop. Sizes 2" to 14"; other basket-type strainers in smaller sizes. Strainer shown has hinged, clamped cover.



Right — Davis No. 75 Strainers. Y-Type, self-cleaning. Sizes from 3/8" to 14"—note tiny 3/8" strainer in foreground.

DAVIS STRAINERS

- FOR steam, air, gases and liquids.
- SIZES for every application —standard strainers from 3/8" to 14".
- PRESSURES up to 1,350 pounds.
- STEEL, semi-steel and bronze bodies. Brass, sheet steel, monel and stainless steel screens and baskets.

STRAINERS aren't "step-children" in the Davis line of valve and control specialties. Careful workmanship, backed by over 65 years' experience assures you of the same high quality that is characteristic of all Davis products—the quality that top plant efficiency demands.

There are Davis strainers to fit your plant needs. A complete line is offered in all standard materials and sizes. In addition, Davis has standardized many sizes and types ordinarily considered as special.

Write today for complete date and specifications on Davis strainers. Experienced Davis engineers are anxious to help you find the solution to your problems. DAVIS REGULATOR CO., 2540 S. Washtenaw Ave., Chicago, Illinois.

DAVIS VALVES

DAVIS REGULATOR COMPANY

"Combustion in the Power Plant", and "How to Buy, Sell and Burn Coal."

EUGENE (JACK) PHILLIPS was the winner of the $5000 first prize awarded by Revere Copper & Brass for best contribution made by a worker to speed the defense program. His achievement

Jack Phillips

is a system for blind landing of airplanes. His idea first came to him in the early '30s, when he was working for American Airlines, but he did nothing about it until a friend was killed in an attempted blind landing.

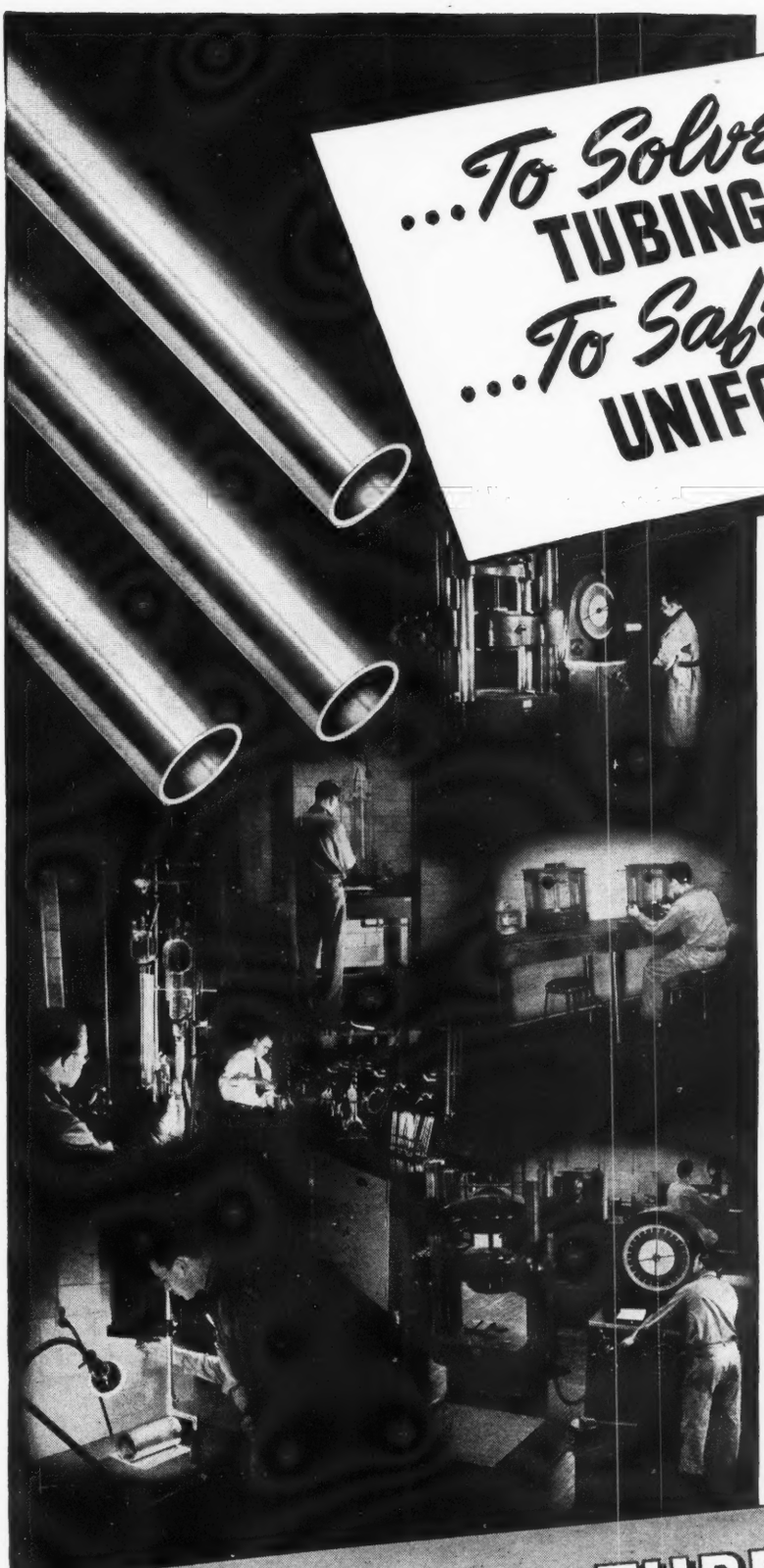
FRED W BUSH and W C SEALEY have been made engineer in charge of transformer sales and engineer in charge of transformer design, respectively, of Allis-Chalmers Mfg Co. Mr Bush, a graduate of Georgia Tech, joined the company in 1928 and has been connected with transformer engineering, development and sales since 1930. Mr Sealey, who was graduated from Carnegie Tech, joined the Allis-Chalmers Transformer Div in 1931, when the company absorbed the American Brown Boveri interests, and prior to 1928 was connected for several years with the transformer div at Westinghouse Electric & Mfg Co.

OBITUARIES

EDWARD W PERRY, 73, former chief engineer of the Massachusetts State Tuberculosis Sanitarium in North Reading, Mass., and at various times connected in an operating capacity with industrial power plants in that state, died at his home in Reading on May 20.

ARTHUR W BERRESFORD, 68, electrical engineer, former vice-president and general manager of Cutler-Hammer, Inc,

(*Continued on page* 182)



...To Solve TUBING PROBLEMS ...To Safeguard UNIFORM QUALITY

...ONE OF THE LARGEST AND MOST COMPLETE CHEMICAL AND PHYSICAL LABORATORIES OF ITS KIND

The Globe Steel Tubes Co., specializing in the manufacture of Seamless Steel Tubes, now has one of the largest and most well equipped chemical and physical laboratories of its kind, concentrating on tubing problems.

This laboratory is maintained for the convenience of our customers and to enable us to exercise exact laboratory control over all production for consistently uniform quality. It is under the supervision of graduate metallurgists and chemists who are prepared to make all chemical, physical and microscopic examinations of steel which present day requirements demand.

In addition to the most advanced machinery and methods in the mill, under the control of a large staff of experienced engineers and technicians, the Globe Steel Tubes Co. laboratory is another important factor which contributes substantially to the inherent quality of Globe "Seamless for Safety" Tubes.

GLOBE STEEL TUBES COMPANY
4050 W. BURNHAM STREET
MILWAUKEE • WISCONSIN

GLOBE Seamless TUBES

GLOBE STEEL TUBES
Seamless for Safety

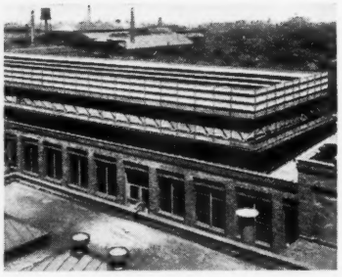
STAINLESS TUBES
BOILER TUBES
CONDENSER AND HEAT EXCHANGER TUBES
MECHANICAL TUBING

SAVE WATER

Use SPRACO Low-Cost COOLING SYSTEMS *for Cooling*

CONDENSING AND CIRCULATING WATER

Definite water shortages are occurring in several sections of the Country. We know of no more economical method of conserving your water supply than installing a Spraco Cooling System for cooling, condensing and circulating water.



Typical Roof Cooling System with Louvre Fence.

A Spraco Cooling System can be installed on the ground or on the roof of a building. Roof systems are provided with a patented louvre fence to prevent spray drift.

Section of Typical Spraco Cooling System at Ground Level.

Spraco engineers are prepared to estimate the cost of revamping or increasing the capacity of existing equipment as well as designing complete new systems.

Write for Cooling Systems Bulletin.

SPRACO AIR WASHERS

Spraco Air Washers are designed primarily for washing and cooling the air for ventilating electrical machinery. We are prepared to furnish replacement parts for any existing Spraco Air Washer and shall be pleased to quote on eliminator plates, nozzles or accessories.

Write for Air Washer Bulletin

SPRAY ENGINEERING CO.

120 Central Street, Somerville, Mass.

and a retired managing director of National Electrical Manufacturer's Association, died at his home in New York recently. Mr Berresford, a native of Brooklyn, was graduated from Brooklyn Polytechnic Institute in 1892. He began his work in electric motor control when he took charge of testing and design work for Ward Leonard Electric Co. Two years later, in 1898 he bought the Iron Clad Rheostat Co, which was sold to Cutler-Hammer in 1900. Joining the Cutler-Hammer organization, Mr Berresford was appointed superintendent in 1901 and general manager in 1905. From 1929 until his retirement in 1934, he was managing director of the National Electrical Manufacturer's Association.

J F Roche, Jr, a director and vice-president of Binks Mfg Co, died recently, following an attack of appendicitis. He was almost 36 years of age. Mr Roche started his business career in the planning department of the Edison General Electric Appliance Co in Chicago. He joined the Binks organization in 1935 and worked in the Industrial Division.

BUSINESS ITEMS

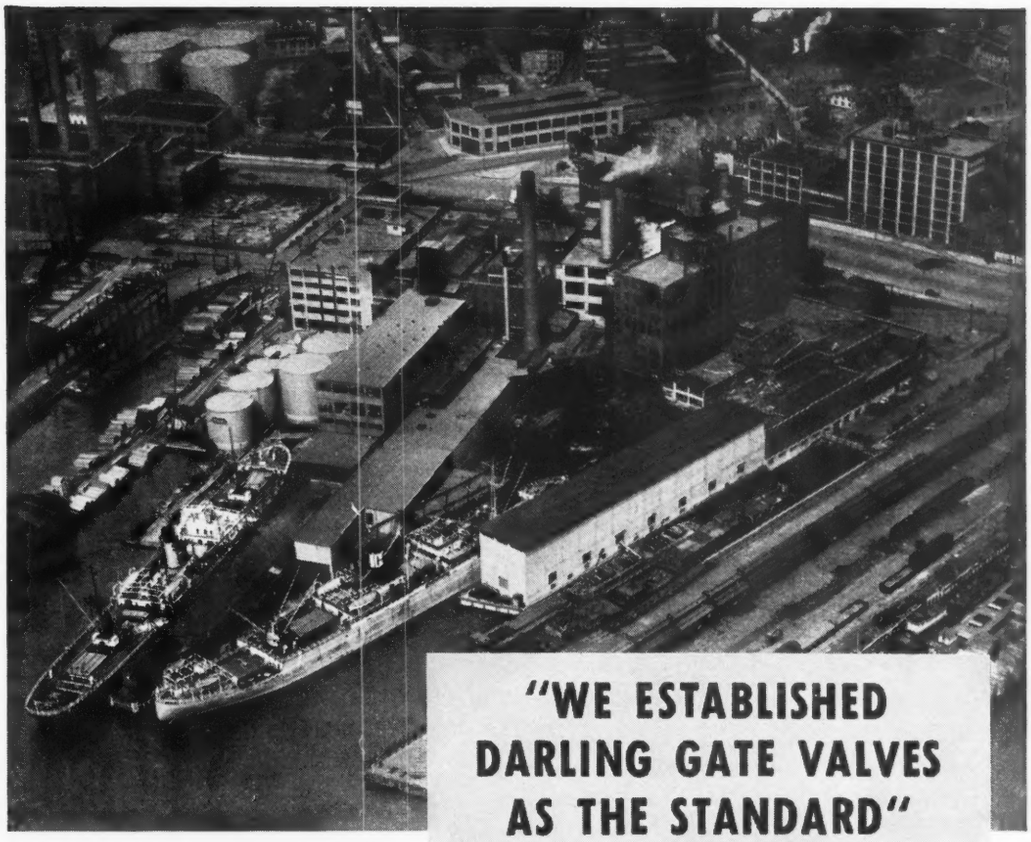
Morris Machine Works, Baldwinsville, N. Y. announces appointment of J L Lynch as district representative in the Detroit area. He is located at 403 Kales Bldg, Detroit.

D W Haering & Co, Chicago, announces several additions and changes of personnel. E H Snyder has been transferred from Wichita, Kansas, office, to Houston, Texas, area, as district manager. C E Erb has been promoted to district manager of Wichita Div offices and laboratories. Expansion in Southwest includes appointment of S R Long and Gray I Thomas as sales engineers at Waco and Dallas, Texas, respectively. New office in midwest has been established at Main St, Pomeroy, Ohio, with N D Russell in charge. Harry McLear has been added to sales staff at Evansville, Ohio, and another chemist, John Daggett, has been added to present staff of chemists and engineers at Chicago, Ill., office.

Maxim Silencer Co, Hartford, Conn., announces opening of Midwest Sales Office at Room 1222-228 North LaSalle St, Chicago, Ill., with Wm A Damerel in charge.

John R Cassell Co, 110 West 42nd St, New York, N. Y. has taken on line of drafting materials manufactured by Frederick Post Co.

Allis-Chalmers Mfg Co's Toledo Ohio, district office, of which W R



"WE ESTABLISHED DARLING GATE VALVES AS THE STANDARD"

writes **Pennsylvania Sugar Co.**

"When we built our by-products plant in 1923, we established Darling Gate Valves as the standard," says Mr. Dan Gutleben, Engineer. "A good many have been operated several times per day for 16 years and are still performing effectively."

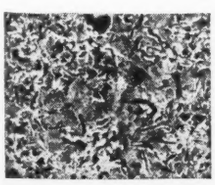
Darling Industrial Valve performance owes its reputation to better manufacturing methods from the very start. It begins with the unique Darling design—noted for its smooth curves and uniform sections. Careful foundry technique involves constant physical and chemical tests . . . plus accurate loading of the cupola . . . plus careful blending of molding sands. Texture and moisture content must be just right, with proper gating and heading. The resulting "dense metal" means better machining, more accurate threading, and freedom from flaws or shrink. See for yourself—specify Darlings for your next installation.

DARLING VALVE & MANUFACTURING CO.

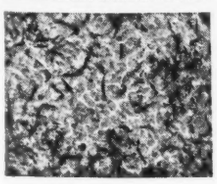
Williamsport, Pa.

Representative in:

New York Philadelphia Houston Toledo Pittsburgh
McPherson, Kan. Huntington, W. Va.



Photomicrograph (mag. 100x) showing the structure of a typical sample of cast iron as ordinarily produced. Note the entrained inclusions tending to break down the strength of the metal and produce leaks.

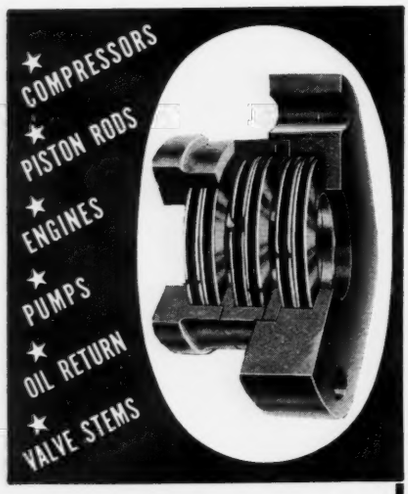


Shows the structure of Darling Dense Metal gray iron. In this dense, fine, homogeneous grain structure the shrinkage porosity has been minimized, with resultant pressure tightness, strength and better resistance to abrasion and corrosion.

DARLING

DENSE-METAL

GATE VALVES



STAR PERFORMANCE in *ANY* Packing Job

For nearly half a century, France "Full-floating" Metal Packing has been used the world over for sealing piston rods in any type of reciprocating engine, pump or compressor as well as valve stems, whether reciprocating or oscillating. A design can also be furnished to prevent crankcase oil leakage and the combined service of preventing crankcase oil leakage and condensation from entering the crankcase.

For star performance (maximum sealing efficiency with minimum maintenance expense), specify France "Full-floating" Metal Packing — the packing that L-A-S-T-S.

Sold on approval Satisfaction Guaranteed

Catalog M-7 tells the complete story. Write for it.

THE FRANCE PACKING COMPANY
Tacony Philadelphia Penna.
Branch Offices in Principal Cities

Original FRANCE METAL PACKING

Mengel is manager, is now located in Toledo Trust Bldg, instead of Second National Bank Bldg.

Name of Builders Iron Foundry, Providence, R. I., has been changed to BUILDERS-PROVIDENCE, INC, and the company will conduct business under same principles as before, with same board of directors and officers.

AMERICAN ENGINEERING CO, Philadelphia, announces the following appointments: George C Lever & Son, 50 Church St, New York, and 972 Broad St, Newark, N. J., as hoist representative for territory of northern New Jersey, greater New York and Long Island; George J Sturmfelsz, Southview Road, Baltimore, Md., as sales representatives for Maryland; H E Mensch, Book Bldg, Detroit, Mich., as sales representatives for Detroit area; and American Steel Export Co, 347 Madison Ave, New York, as foreign sales representatives.

MANNING, MAXWELL & MOORE, INC, announces additions to sales staff. C G Tyler, formerly connected with Railroad Div and Chicago District, has joined the Industrial Div and takes over territory served from Columbus, Ohio. Arthur B Bleecker, formerly with Los Angeles branch of Creamery Mfg Co, will represent all four industrial divisions of the company in Pacific Northwest, covering Seattle and Portland territories.

W H BIXBY, INC, Des Moines, Ohio announces addition of R C Adams to staff. Mr Adams will be actively engaged in sales-engineering work, handling products of Cochrane Corp, Bartlett-Snow Co, Diamond Power Specialty Co, Hays Corp, Detroit Stoker Co, and A P Green Fire Brick Co.

Whiting stokers will be manufactured and sold from plant designed and planned for their production by the WHITING CO, at 4711-19 W North Ave, Chicago, Ill. New arrangement is outgrowth of further development of Whiting stokers, formerly made by Whiting Corp at Harvey, Ill. A E Bottenfield will continue in charge of distribution.

PITTSBURGH PIPING & EQUIPMENT CO, Pittsburgh, Pa., announces election of following officers: Charles R Rall, president and treasurer; Lewis K Hamilton, vice president; Joseph F Gardner, secretary; Karl F Tiegel, director of purchases and estimates; and D S Larsen, chief engineer.

Effective April 25, 1941, the Philadelphia office of PANGBORN CORP is located at 901 Beury Bldg, 3701 N Broad St. Forrest G Sharpe, formerly assistant to sales manager, has been appointed Philadelphia sales engineer

"STANDCO" PILLOW BLOCKS

Fig. 1635

Combining clamp block and pillow block requirements in one type, the "Standco" shown above is sturdily built and is offered in a wide range of sizes. Babbitted bearing surfaces are finished beautifully smooth, both faces machined. It can be depended on for long, trouble-free service.

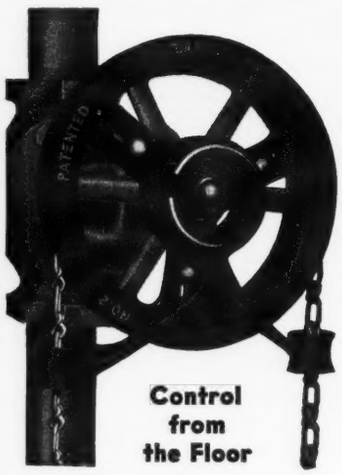
Fig. 32

"Standco" Ball and Socket Pillow Block, Ring or Wick Oiling, Plain or Collar End Babbitted Bearings.

Write for Bulletin

STANDARD PRESSED STEEL CO.
JENKINTOWN, PENNA.
Boston Detroit Indianapolis Box 577 Chicago St. Louis San Francisco

Make Your Overhead Valves SAFE And Easy to Reach---



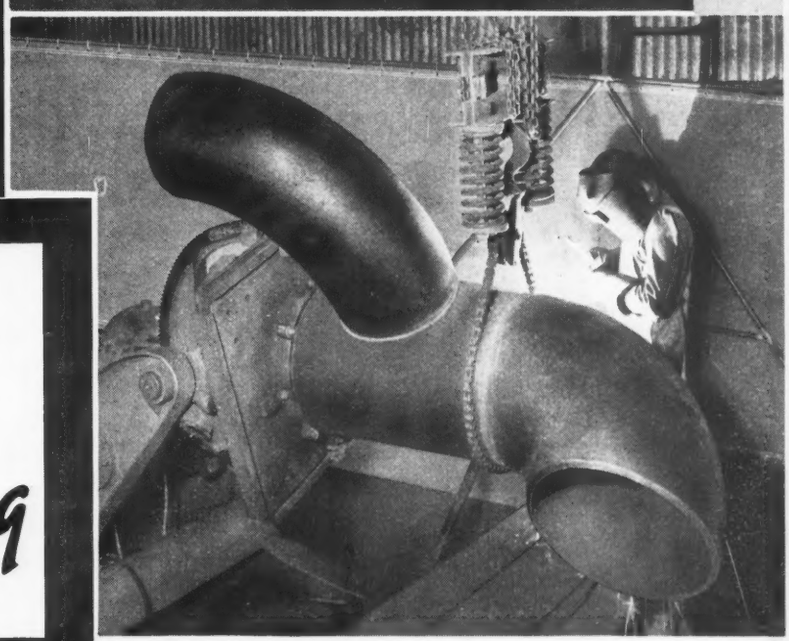
With the Babbitt Rim for Valves you eliminate danger and banish the step-ladder. You can now place your valves wherever they come economically and conveniently. They fit any valve. Let us tell you more about them. Write today.

BABBITT STEAM SPECIALTY CO.
New Bedford, Mass.

Controlled WELDING CONDITIONS

A Factor in High Quality Fabrication at

Pittsburgh Piping



WELDING plays an important part in the fabrication of all types of piping. At Pittsburgh Piping and Equipment Co., the welding procedure is rigidly controlled by modern shop practice and metallurgical laboratory supervision.

For example, "positioners", such as is illustrated above, are employed whenever possible in making circumferential welds. This equipment enables the welder to work in a down-hand position, without fatigue and consequently results in better workmanship.

Qualitative tests of all welding operators are made at regular intervals by Pittsburgh Piping technical staff. As a result, the welders are qualified to weld piping in accordance with ASME Power Boiler and Unfired Pressure Vessel Codes as well as the Code for Pressure Piping, and U. S. Government specifications.

This thoroughness of welding control is characteristic of the high quality of piping fabrication performed at Pittsburgh Piping.

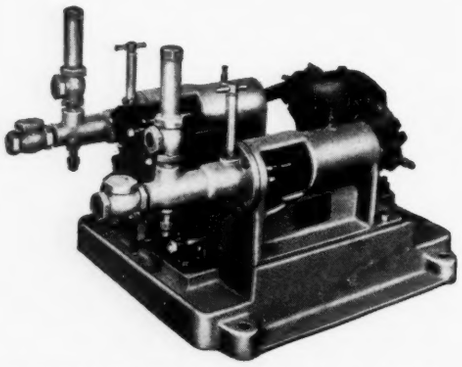
PITTSBURGH PIPING & EQUIPMENT CO., 10 FORTY-THIRD ST., PITTSBURGH, PA.

Woolworth Building, New York — Occidental Building, Indianapolis — Peoples Gas Building, Chicago — Union Guardian Building, Detroit
Public Square Building, Cleveland — Liberty Life Building, Charlotte — 10 High Street, Boston — 525 Market Street, San Francisco

PROTECT YOUR STEAM GENERATING EQUIPMENT BY POSITIVE PROPORTIONING WITH %PROPORTIONEERS% CHEMICAL FEEDERS

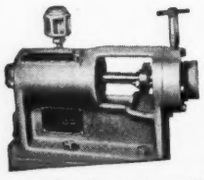
Complete chemical treating and feeding methods for the power plant include the handling of phosphates, sulphites, sulphates, sulphuric acid, etc. by:

1. **Constant rate Adjust-O-Feeder for low and high pressure service.**
2. **Shot feed Adjust-O-Feeder with manually adjustable time cycle control.**
3. **Flow-proportional Adjust-O-Feeder or Treet-O-Unit with control from—(a) reciprocating boiler feed pumps—(b) electric motor-driven control from either mechanical or Venturi meters.**



Standard Adjust-O-Feeder for pressures up to 250 lbs. Capacities from 5 gph. to 10 gpm.

The accuracy and performance of a proportioning pump depend on these features:



Cross head guide with visible stroke length scale.

Micrometer crank arm with adjusting screw.

Connecting rod assembly showing needle bearings.

Use %Proportioneers% Chemical Feeders for general plant water supply; and deaerator treatment for direct feed to boiler drums. Send for Bulletin SM 122A

% PROPORTIONEERS, INC. %

16 CODDING STREET, PROVIDENCE, RHODE ISLAND

to fill the vacancy caused by the sudden death of William T Randall.

H J Hooks has resigned as president of Wolverine Tube Co, effective May 23. To fill the vacancy, Charles C Limbocker was elected president, also retaining the position of chairman of the board. George H Klein was elected to the board of directors to fill the vacancy caused by Mr Hooks' resignation.

Ordered to Begin Wolf Dam Construction

Orders to start immediate construction of the $55,000,000 Wolf Creek Dam, near Jamestown, Ky., were received in June by Major O E Walsh, U.S. district engineer at Nashville, Tenn. The dam, which will be built on the Cumberland River, will have a capacity of 250,000 kw. It will be constructed under Army supervision, and not under the Tennessee Valley Authority. Major Walsh predicted the dam would be complete within "2½ or 3 years."

Wisconsin Public Service Awarded Coffin Medal

The Wisconsin Public Service Corp, a utility organization serving an area of 10,000 square miles, received the Charles A Coffin medal for 1940, awarded by the General Electric Co for outstanding record of performance. The medal was presented at the ninth annual meeting of the Edison Electric Institute held in Buffalo, N. Y., by J E Davidson, president of the Nebraska Power Co, and member of the prize awards committee.

Among the accomplishments having a direct influence upon the committee's choice were increased residential and farm sales, increased electric revenue against rate reductions, increased appliance sales, reduced interest charges due to refinancing, in spite of an increase in interest-bearing securities, program of cost analyses and comparison of practices whereby electric operating expenses were reduced 8½% against a general national increase in such expenses; adoption of a guaranteed annual wage plan; development of a plan of reservoir operation, which, without added investment, increased firm hydro power almost 40%, and the rebuilding of the Grandfather Falls Hydro plant at a construction cost comparable to that of steam stations.

INTERNATIONAL HARVESTER COMPANY HAS TWENTY-FOUR THERMIX FAN-STACKS

Back in 1928, the International Harvester Company installed 3 Thermix Stacks at their Milwaukee plant. These stacks made good, so good in fact, that they have since ordered 21 additional for their other plants thruout the country.

Repeat orders are the best evidence of satisfaction. Some people may take chances when trying a product the first time, but they do not duplicate their orders time after time unless entirely satisfied.

Scores of other concerns have duplicated their original Thermix Stack orders. The Procter & Gamble Company, for instance, now have ten, Schenley Distillers have seven, etc.

The Thermix combines, in a single simplified unit, a mechanical-draft fan, a stack and breeching.

Thermix Stacks save on installation cost, save on engineering and purchasing cost, save power, save in the cost of fuel and save in up-keep.

May we send you our bulletin?

PRAT-DANIEL CORPORATION

Also manufacturers of Thermix Controlled Multicyclones, and Tubular and Recirculator Dust Collectors

88 S. WATER ST., PORT CHESTER, N.Y.

Representatives in Principal Cities

Here's one sure, safe and easy way to rid your boiler feed water of silica and organic substances *without* danger of leaving scale-forming or corrosive residuals—TREAT WITH FERRISUL (anhydrous ferric sulfate)!

Ferrisul's floc is highly absorptive, forms immediately, settles rapidly, is stable over the entire pH range above 3.5, leaves no harmful coagulant residuals!

Ferrisul is free-flowing and easy to handle. Dry, it requires no expensive storage tanks, can be transferred on any standard conveyor system and introduced into the treatment in standard dry-feed machines or in solution feeders.

Write for the new Ferrisul booklet which gives complete information. MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston, Massachusetts.

Ferrisul is also an effective coagulant for treatment of sewage, industrial waste, municipal water supply.

MONSANTO CHEMICALS
SERVING INDUSTRY . . . WHICH SERVES MANKIND

LET'S GO! U.S.A. KEEP 'EM FLYING!

Progress in Diesel Operation

▶KANSAS CITY, MO., JUNE 13—Meeting in an area where diesel and gas engines find wide application, the 14th National Meeting of the Oil and Gas Power Division, ASME, held June 11-14 at the Hotel President in Kansas City, Mo., featured discussion of matters having unusual interest for engine users and plant designers.

Layout, design, and construction of foundations for vertical diesel engines ranks high in importance among the factors essential to successful operation. First step in the design is a study of the general features of the area around the installation (proximity, construction and use of surrounding structures, possibility of interference with other operations in the same building, etc) according to Kenneth H Larkin, Burns & McDonnell Engrg Co, Kansas City, Mo. Definite knowledge of the foundation soil, as determined by auger borings, is likewise important. Having explained the nature and characteristics of engine vibrations, Mr Larkin outlined methods used in engine design to eliminate or reduce vibration.

Kenneth H Larkin, Burns & McDonnell Engineering Co, gives some of the fine points of foundation design

Tabulation of foundation yardage recommended by engine builders gives average values of from 0.091 cu yd per engine hp for 8-cyl engines to 0.141 for 3-cyl engines, with no definite relation between yardage and either engine size or speed. The speaker pointed out that these figures represent results of experience and stressed the fallacy of economizing on foundation size. He likewise presented considerations in designing foundation details, such as anchor bolts, pits, and openings or chases for piping.

Considerable interest was evidenced

Rockbestos Wires Permanently Resist
HEAT-MOISTURE-OIL-GREASE-FIRE

These wires are but a few of the 118 different permanently insulated standard constructions developed by Rockbestos to withstand the destructive action of heat and moisture, oil, grease and corrosive fumes without drying out, cracking, rotting, swelling or failing. All of them are absolutely fireproof. File this page under "Wires for Severe Operating Conditions" and refer to it when you reach the wire-specifying stage of your planning. For complete information send for catalog.

Rockbestos Products Corporation, 807 Nicoll Street, New Haven, Connecticut

600 VOLT A.V.C. SWITCHBOARD WIRE — TABLE B
(Underwriters' Type AVB)

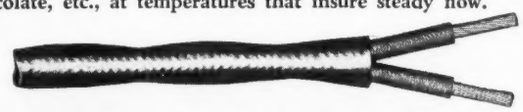
Sizes No. 18 to 4/0 A.W.G. with varnished cambric and felted asbestos insulation and gray, black, white or colored flameproof cotton braid.

Combine fire insurance and fine appearance in your switchboards with Rockbestos Switchboard Wire. It is absolutely fireproof and will not dry out under heat. Sharp, clean bends can be made without cracking as the asbestos wall acts as a cushion under the braid. Rockbestos A.V.C. Hinge Cable and Switchboard Bus Cable have the same fireproof and heatproof characteristics.

INDUSTRIAL HEATING CABLE — TABLE LH

No. 19 A.W.G. nickel-chromium wire insulated with .040" of felted asbestos and covered with 4/64" waterproof lead sheath.

This pliable cable distributes a mild heat evenly over a large area. Prevents freezing of water pipes, wet pipe sprinkler systems, etc. Keeps conveyor pipes for fuel oil, soap, varnish, ink, chocolate, etc., at temperatures that insure steady flow.



ALL-ASBESTOS FLEXIBLE CORD — TABLE CA

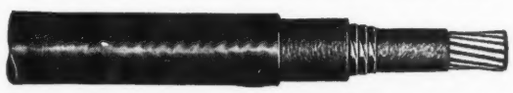
Sizes No. 10 to 18 A.W.G. with two or three conductors insulated with felted asbestos, covered with asbestos braid. Also in A.V.C. (asbestos and varnished cambric) constructions.

This heat-resisting flexible cord is ideal for high-wattage lighting units, floodlights, blueprint machines, apparatus, etc., which require a heavy duty, enduring cord. For moisture-resistant construction specify the A.V.C. type. Labeled cord with polarized conductors if desired.

600 VOLT A.V.C. BOILER ROOM WIRE — TABLE C
(Underwriters' Type AVA)

Sizes No. 18 to 4/0 A.W.G. This construction for sizes 18 to 8, sizes 6 to 4/0, have another wall of felted asbestos next to the conductor.

For lighting and control circuits exposed to heat and moisture, oil, grease, corrosive fumes or fire hazard, such as exist around furnaces, ovens, lehrs, soaking pits, boilers, etc., this widely used A.V.C. construction is ideal. Also for locomotive panel wiring and for switchboards requiring an asbestos braided wire.



600 VOLT A.V.C. POWER CABLE — TABLE E
(Underwriters' Type AVA)

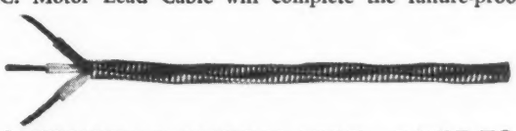
Sizes No. 18 A.W.G. to 1,000,000 CM insulated with laminated felted asbestos and varnished cambric, and asbestos braid. Other constructions for service voltages up to 8000.

This cable is recommended for power circuits and hot spot wiring in or around boiler rooms, ash pits, steam tunnels, soaking pits, tenter frames, glass plants, steel mills, etc. The asbestos and heat-sealed varnished cambric construction has ample moisture resistance and withstands high temperatures indefinitely.

ASBESTOS INSULATED MAGNET WIRE

Round, square and rectangular asbestos insulated conductors finished to meet varying winding conditions and coil treatment requirements.

Protect your motors against heat-induced breakdowns with class B windings of Rockbestos Heat-Resisting Magnet Wire. Leads of A.V.C. Motor Lead Cable will complete the failure-proofing.



THERMOSTAT CONTROL WIRE — TABLE TC

Sizes No. 14, 16 and 18 A.W.G. in two to six conductors with 12½, 25 or 32 mil wall of felted asbestos insulation and cadmium plated steel armor.

A multi-conductor control wire for low voltage intercommunicating, signal and temperature control systems. Its lifetime insulation and rugged steel armor will give you troubleproof circuits.

600 VOLT ALL-ASBESTOS RHEOSTAT CABLE—TABLE R
(Underwriters' Type AI)

Sizes No. 18 A.W.G. to 1,000,000 CM insulated with a heavy wall of felted asbestos, covered with a rugged asbestos braid finished in black, white or colors.

Use this power and rheostat cable for wiring rheostats, switchboards, elevator and locomotive control panels and electrical equipment exposed to heat, fumes and fire hazard. Also for general open wiring in dry, high temperature locations. For solid conductor specify Rockbestos Rheostat Wire, Table A.

600 VOLT A.V.C. MOTOR LEAD CABLE — TABLE L
(Underwriters' Type AVA)

Sizes No. 18 A.W.G. to 1,000,000 CM insulated with two walls of felted asbestos and a high-dielectric, heat-sealed varnished cambric insert, covered with heavy asbestos braid.

Heatproof, fireproof, greaseproof and oilproof, this cable will not dry out and crack, won't burn or carry flame, and will remain permanently flexible. For coil connections, motor and transformer leads where extreme heat and fire hazards are encountered as in steel mills, boiler rooms, etc.

600 VOLT A.V.C. CONTROL CABLE

In one to 19 conductors. Standard stranding A.W.G. No. 12 — 19/No. 25 and No. 9 — 19/No. 22. Other strandings furnished to order.

Designed for use under conditions too severe for control cables with other types of insulation which deteriorate rapidly when exposed to high temperatures. Operates without failure under the attack of heat, oil, grease or corrosive fumes and may be installed in conduit as it has ample moisture resistance.

Also refer to McGraw-Hill Electrical Buyers Reference

ROCKBESTOS — *the wire with permanent insulation*

GRADUAL CONTROL IS G-R-A-D-U-A-L

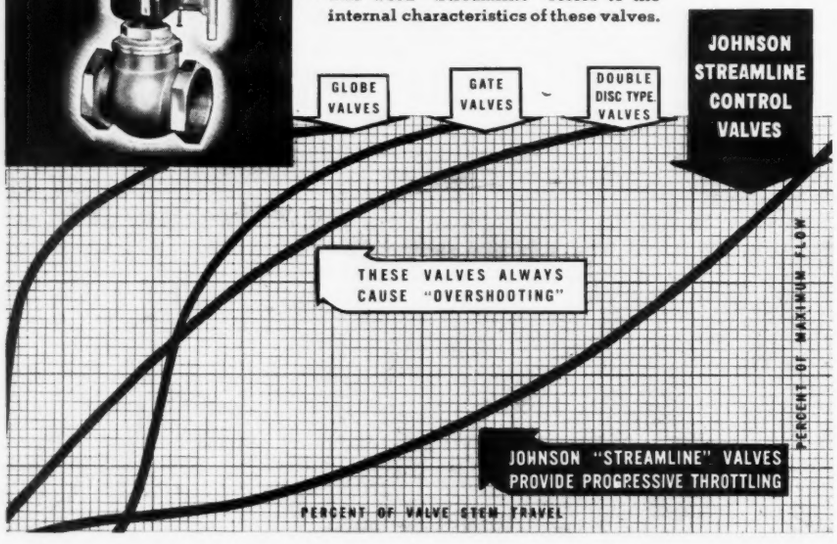
When JOHNSON "Streamline"* VALVES ARE USED

ABOVE—*Modulating valve with "Sylphon" metal diaphragm.*

BELOW—*Pilot-operated modulating valve with rubber diaphragm.*

THE partial chart below indicates the impressive advantages of Johnson "Streamline" Control Valves. Since their introduction, several years ago, long-sought gradual action, denied by other types of valves, has been possible. The Johnson "Streamline" is more than just another valve with disc and seat of special design. Beyond that, the construction of the entire unit is such that perfect throttling control is produced. Note the distinctive characteristics shown by the curve. With Johnson "Streamline" valves, the percentage of steam flow does not "jump ahead" of the valve stem travel. No overshooting! True gradual action!

* The word "Streamline" refers to the internal characteristics of these valves.

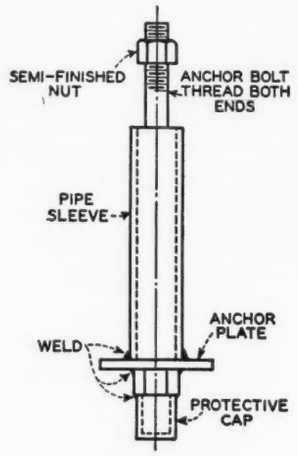

GLOBE VALVES
GATE VALVES
DOUBLE DISC TYPE VALVES
JOHNSON STREAMLINE CONTROL VALVES
THESE VALVES ALWAYS CAUSE "OVERSHOOTING"
JOHNSON "STREAMLINE" VALVES PROVIDE PROGRESSIVE THROTTLING
PERCENT OF MAXIMUM FLOW
PERCENT OF VALVE STEM TRAVEL

Johnson "Streamline" valves are available with "Sylphon" seamless metal bellows or with enclosed and protected diaphragms of super-aged and heat resistant rubber. Rubber diaphragm "Streamline" valves are fitted, as an optional feature, with Johnson's ingenious pilot mechanism.

Smooth gradual operation, independent of variation in friction and pressure. Pilot-operated "Streamline" valves, controlled by Johnson "adjustable sensitivity" instruments, represent the ultimate in superior GRADUAL CONTROL. Ask for descriptive Bulletins.

JOHNSON
Automatic TEMPERATURE AND AIR CONDITIONING Control
JOHNSON SERVICE COMPANY, MILWAUKEE, WIS. & BRANCHES IN PRINCIPAL CITIES

in parts of the paper dealing with connection of the foundation to the subsoil and procedures to be followed in meeting special subsoil conditions. After a brief discussion of the theory of vibration isolation, Mr Larkin discussed the characteristics of various damping materials and devices and the effect on their characteristics of different subsoil conditions. The



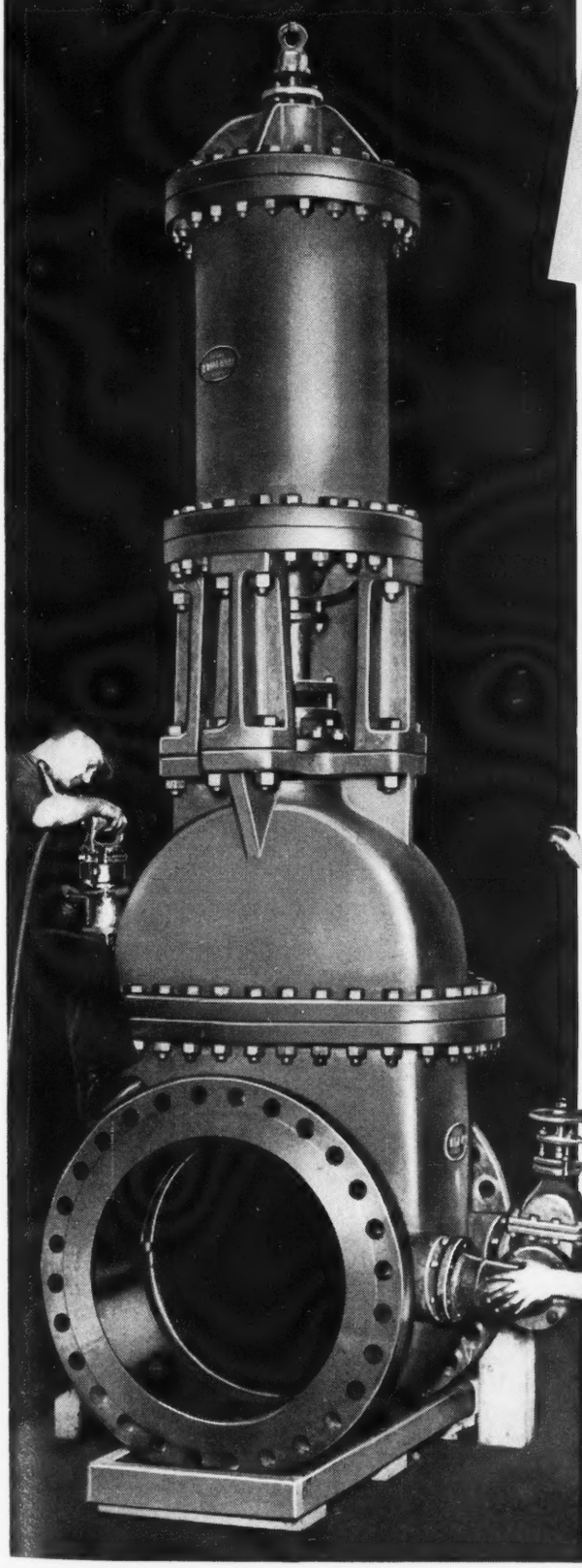
Foundation anchor bolts

paper concluded with recommendations on mixing, placing, and curing concrete, on reinforcing, and on grouting. Active discussion of the paper centered on handling special vibration problems.

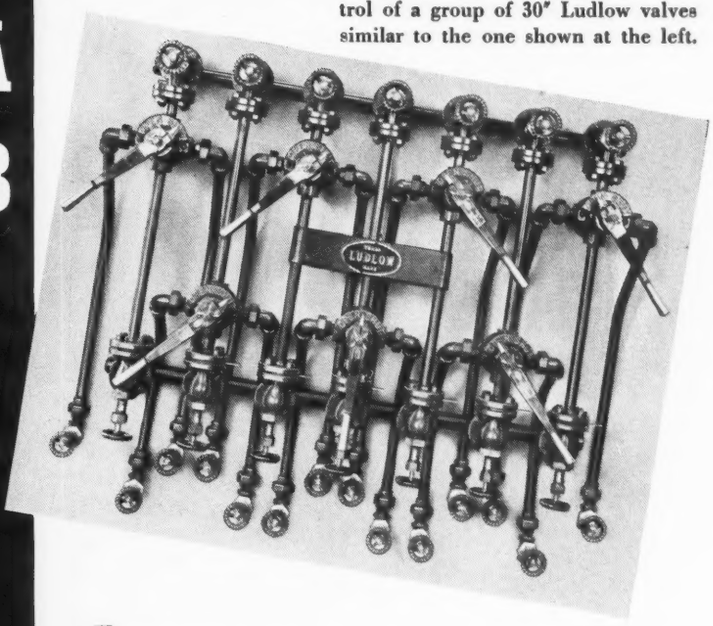
Two aspects of engine maintenance were covered in related papers: "Internal-Combustion-Engine Casualty Experience" by H J Vander Eb, Hartford Steam boiler Inspection and Insurance Co, and "Inspection Procedures and Instruments for Diesel Engines" by E R Spencer, The Cooper-Bessemer Corp. Before presenting data on accident experience on approximately 75% of the insured engines, Mr Vander Eb pointed out that engine installations must meet certain requirements as to manufacture, condition, freedom from overloads, nature of cooling-water system, competence of operators, and provision of essential controls and instruments. He also carefully explained the definition of "accident", according to insurance usage.

The paper included three interesting and valuable tabulations: the first showed essential engine data, part failing, cause of failure and cost of damage for 413 accidents encountered in 1450 engine years (three calendar years). The second table analyzed these accidents by cause, showing that bearing troubles accounted for 31% of the total, that cylinder heads, cylinders, and liners

BIG FOR A BIG JOB



Hydraulic switchboard for remote control of a group of 30" Ludlow valves similar to the one shown at the left.

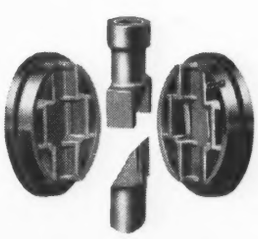


LUDLOW builds big valves, too! For example, the one shown is part of an order for 13 valves, which were specially constructed to serve in a plant that's vital to our defense program.

These valves are designed for 250 lbs. working water pressure, and the cylinders operate at 275 lbs. oil pressure. These cylinders are lined with a special nickel alloy honed to glass-like smoothness to reduce friction and leakage. A special hydraulic switchboard was designed by Ludlow for the operation of the big valves by remote control.

Big or little, Ludlow valves can be your logical choice. Why not call in the Ludlow engineers for consultation on your next valve installation? There'll be no obligation, of course.

Ludlow Principle Self-releasing 30° angle wedges and flexible action gates self-adjusting to seats for improved performance, longer life.



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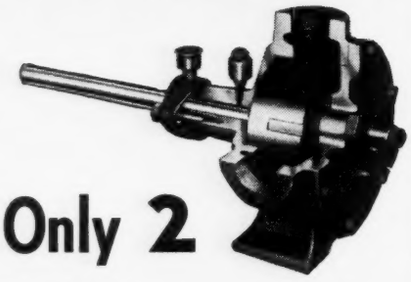

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accounted for 21.8% and that piston accidents accounted for 14%. The final table gave accident frequencies for ten years, from 1931 to date, showing a decrease in frequency of from 1:2.0 to 1:3.5. Mr Vander Eb stressed the advantages of closed-circuit cooling and pointed out that the premium for closed-circuit installations is 40% less than that for open-circuit systems. Discussion clarified several points at issue, particularly with respect to comparison of experience on the limited number of insured engines with experience on the much greater number of uninsured engines and also with respect to experience on steam engines and steam plants as a whole.

The paper on inspection procedures should have special value to operators as the author presented a complete picture of the methods to be used in checking an engine's condition and

C E Beck, Busch-Sulzer Bros-Diesel Engine Co, announces the social program for the meeting

gave recommended allowances for wear, misalignment and deformation. Although the time allowed between inspections depends on load factor, nature of fuel, frequency of starting and stopping, operating conditions, program of running repairs and lubrication, Mr Spencer suggested 8000 to 10,000 hours between inspection and overhaul as a good average figure for heavy-duty slow-speed engines.

Detailed recommendations were given for inspecting bearings, checking shaft alignment, adjusting main bearings, inspection of cylinder liners and measurement of linear wear, aligning connecting-rods with piston and crankpin bearings, inspection of pistons, and tightening connecting-rod bolts. In each case, necessary tools and instruments were described along with the

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1. Tightness
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These two essentials of satisfactory valve performance in boiler blow-off service are combined in the Everlasting Duplex Blow-off Unit — proven in thousands of installations and covered by the most generous guarantee ever made on any type of valve.

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Narrow, flexible sealing ring assures fluid-tight seal . . . flow of fluid continues as valve closes but flow of solid material is checked off by constrictor construction thus assuring a clean seat.

Made in sizes 1½-in., 2-in., and 2½-in. for 250-lb., 300-lb. and 600-lb. Comply with all code requirements.

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step-by-step procedure for their use. Discussors questioned the suggested method for measuring and stating liner wear but all agreed that some standard practice should be devised and agreed on, to make reported values of liner wear comparable.

In a session devoted to supercharging, J B Harshman, Stanolind Pipe Line Co, described operating experiences with Buchi exhaust turboblowers for supercharging 4-stroke-cycle air-injection engines in pipeline service. After a resume of the history and general methods of supercharging, Mr Harshman presented considerable experience data on the Buchi equipment installed on several engines of the Stanolind system. On the basis of this experience he concluded that use of supercharging to increase the horsepower of existing pipeline engines was not only practicable but economically justifiable. Supercharging a 500-hp engine gave 250 hp additional capacity at a cost of about $50 per hp, including new gears for increasing the speed of the pump. This compares with a cost of about twice as much per installed hp for additional pumping units. Supercharging is also useful on pipeline service for handling temporary peak loads.

Supercharger Operation

The only disadvantage encountered in operation of the supercharged units has been inability to operate these units at loads below the original rated hp. Failure of the exhaust-driven turbine to compensate automatically for load variation appears to result in excess air, poor combustion and consequent accumulation of carbon, necessitating removal of the turbine rotor for cleaning. Mr Harshman suggested the following improvements for maximum success: (1) proper manifolding to prevent overlapping of exhausts from different cylinders. (2) provision for regulation of air at low loads to insure proper combustion, and (3) changes in supercharger design to permit installation in different positions to simplify piping and to permit adaptation to existing piping.

Results of tests comparing an engine fitted for under-piston supercharging, used in Europe but not previously tried in this country, and a trunk-piston engine of nearly identical output, were reported by E S Dennison and W A Morain, Electric Boat Co. Using the under side of the piston as an air compressor makes it possible to supercharge without use of external accessories and effects a valuable saving in space. However, the crosshead con-

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ADAMANT has a P.C.E. of over 3000° F.

This great strength of the bonding material assures joints that are strong as the brick they bond. Adamant is smoother, too. Over 66% of the dry material passes through a 200 mesh standard Tyler sieve. For more facts about Adamant and other AdaProducts write

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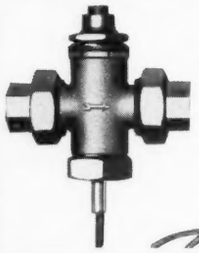

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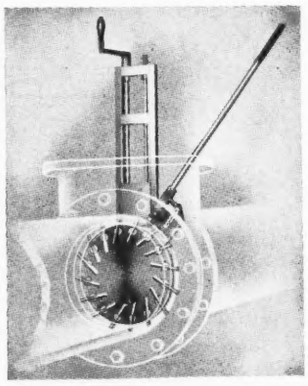
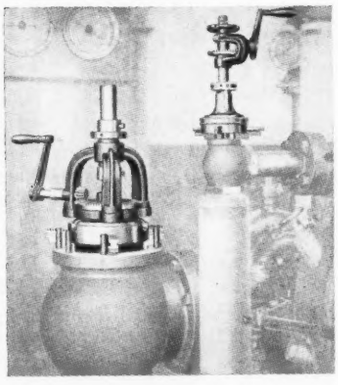
Cost of new valve	?
Number of times valve can be reseated	?
Time lost for removal or replacement	?
Labor for removal or replacement	?
Pipe section replacements	?
Remaking tight connections	?
Truing up seats of new valves	?
	?

FIGURE IT OUT FOR YOURSELF

It will add up to this:

IT'S A LOT CHEAPER TO RESEAT A VALVE THAN REPLACE ONE . . .





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Features your want:	FYR-FEEDER:
1. Modern Firing Method	✓ The FYR-FEEDER is the newest type of spreader stoker, which in turn is the latest development in coal firing equipment. Burns cheapest coal, thereby reducing coal bills. Excellent results with wet or dry coal. Users report savings up to as much as $4.00 per ton by using local screenings, yard sweepings, etc.
2. Simple Construction	✓ The FYR-FEEDER is the simplest spreader stoker built. (See accompanying sketch.) No steam jackets, no water jackets, no high pressure fans, no furnace gases needed to dry coal before firing, no high speed moving parts in contact with coal or exposed to radiant heat of furnace. Compare FYR-FEEDER'S neat, compact, streamlined appearance with conventional bulky, exposed stoker designs.
3. Dependable Performance	✓ Even in small FYR-FEEDER units, users get the dependability of two independent burners. No trouble with clogging due to wet or damp coal. Virtually immune to damage from any source.
4. High Firing Efficiency	✓ Ability to follow fluctuating loads closely . . . use of a thin fire bed . . . excellent turbulence in furnace, all make for high average efficiency.
5. Low Operating Cost	✓ Power requirements for the FYR-FEEDER are very low. Little attention or supervision is required. Fireman's work is made easy because operation is automatic.
6. Quality Construction	✓ Fine grained semi-steel castings, precision cut gears, modern streamlined steel plate work all contribute to a standard of quality second to none. Assembly includes finest motors, fans, controls, etc. obtainable.
7. Reliable Engineering	✓ More than 23 years of successful combustion engineering experience in engineering and building thousands of overfeed stokers stand back of the FYR-FEEDER. A drawing is made for each installation by our Engineering Department.
8. Maximum Return On Investment	✓ The FYR-FEEDER has repeatedly demonstrated its ability to pay the highest return available. We will be glad to submit a proposal on your requirements. Write or use coupon below.

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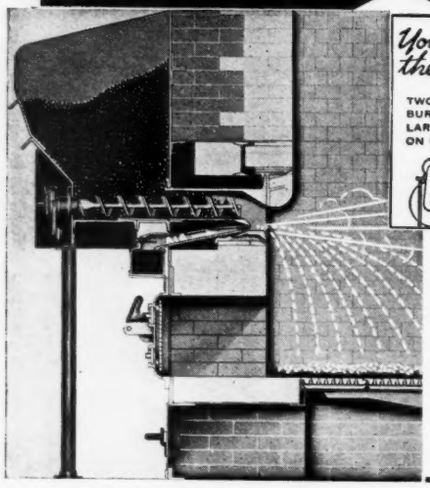

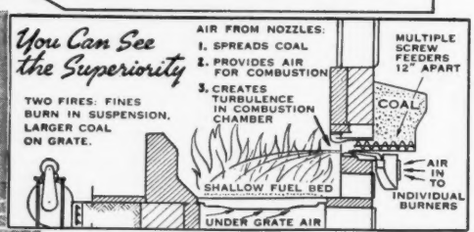
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TWO FIRES: FINES BURN IN SUSPENSION, LARGER COAL ON GRATE.
COAL
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struction necessary is relatively costly and the authors made no claims as to the economic advantages of such a unit for general purposes. The unit tested and a later one have seen several months of satisfactory service.

Experiments made by B H Jennings, Northwestern Technological Institute, and T E Jackson, Lehigh University, indicate that measurement of the pressure existing just before exhaust in a diesel engine may be used to determine the distribution of load among the cylinders of a multicylinder engine and so may be used to make operating adjustments.

The authors explained the theory behind the suggested use of pre-exhaust temperature and presented test data showing that under known conditions of injection, timing, and compression ratio, it was possible to evaluate both indicated and brake horsepower in terms of pre-exhaust pressure. Experiments show the same method is applicable to spark-ignition engines.

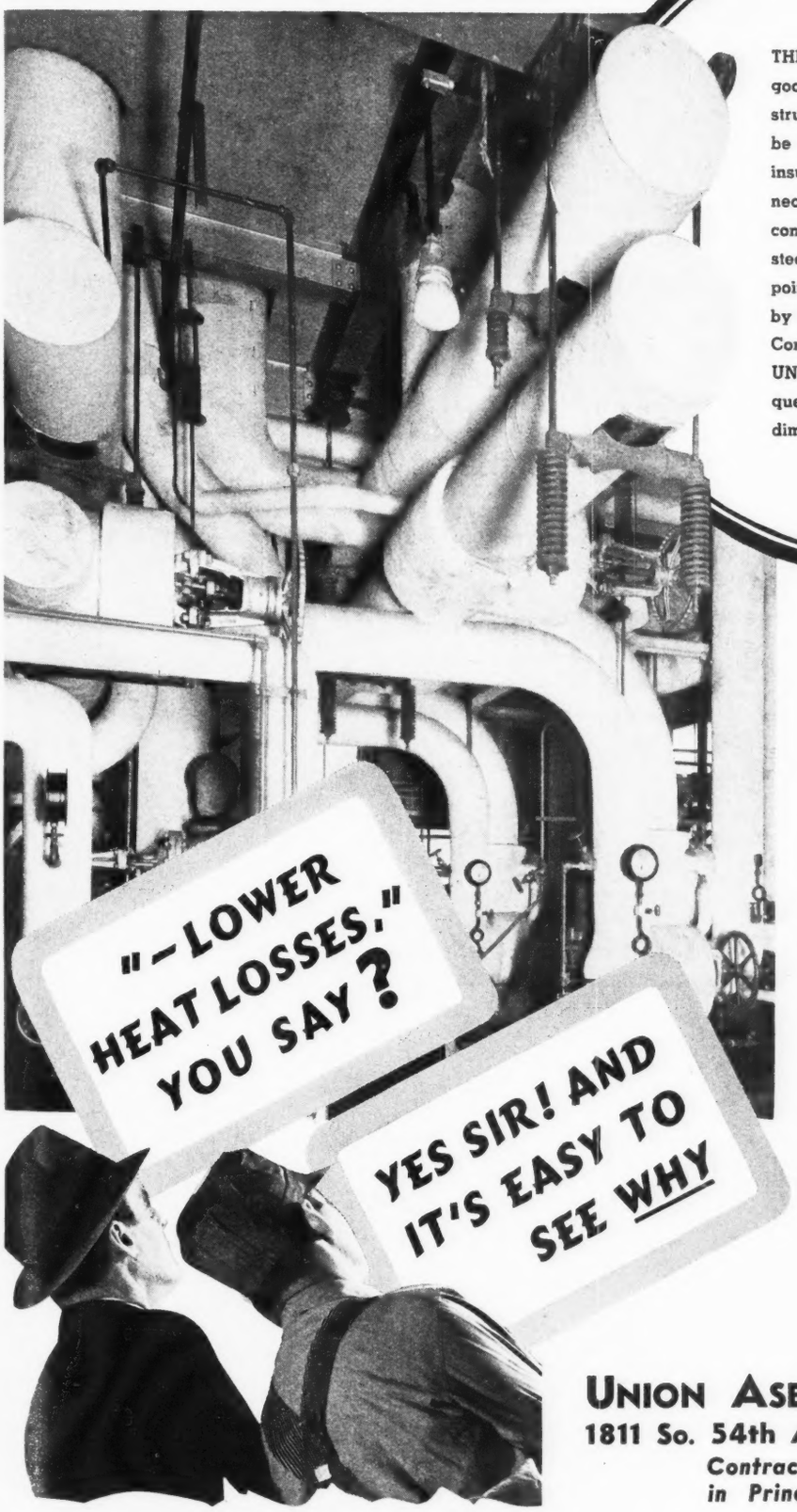
By means of a theoretical analysis, C W Good, University of Michigan, showed that the power loss accompanying combustion knock may be attributed to a mass vibration of the gas within the combustion chamber, rather than to radiation, as has been supposed. The analysis also indicates that the loss with the diesel cycle is relatively less than with the Otto.

Purifying Lube Oil

Methods for purifying lubricating oil, and fuel oil where necessary, were discussed at another session. Use of centrifuges for this purpose was described in a paper by C W Bryden, De Laval Separator Co; in Mr Bryden's absence the paper was read by D A Gardner of the same company. The author told of early applications of centrifuging to oil purification, pointed out methods of operation to insure best results, and gave representative cost figures.

In a companion paper, W C Bauer, Briggs Clarifier Co, discussed use of adsorbent filters for continuous maintenance of lubricating oil. He began by explaining the significance of tests used to describe the condition of a lubricating oil and continued with test data comparing adsorbent filters of the molded cartridge type with various competitive units. Discussion indicated that operators of large diesel plants lean to a combination of purification methods, using centrifuges for removing the great mass of impurities and adding either continuous bypass or batch treatment with various types of absorbent or adsorbent units.

UNIBESTOS



THE picture at the left offers a good illustration of UNIBESTOS' structural strength. Big pipe can be supported without cutting out insulation at bearing points. No necessity for any metal-to-metal contact. Simply lay an ordinary steel saddle over the insulation at points where the pipe is supported by rollers, tie rods, or other means. Compression load curves for UNIBESTOS will be supplied on request to engineers designing and dimensioning such saddles.

TESTS made by independent authorities have repeatedly indicated that UNIBESTOS possesses higher thermal efficiency than the most commonly used insulations. BUT, perhaps even more important, is the fact that UNIBESTOS also possesses distinctive physical features that make for higher actual "on-the-job" efficiency. Elimination of metal-to-metal contact at bearing points (as pointed out in the above caption), convenience in covering flanges and in making efficient expansion joints are just a few of the reasons why better installations are commonly secured with UNIBESTOS.

UNIBESTOS is offered in a complete range of sizes: sectional insulation for all pipe diameters up to 36", thicknesses up to 5". Sheets up to 36" x 36" x 5". Available in 750° F. or 1200° F. material, or any combination of the two in single layer construction for any intermediate temperature. We will be glad to send samples and complete information.

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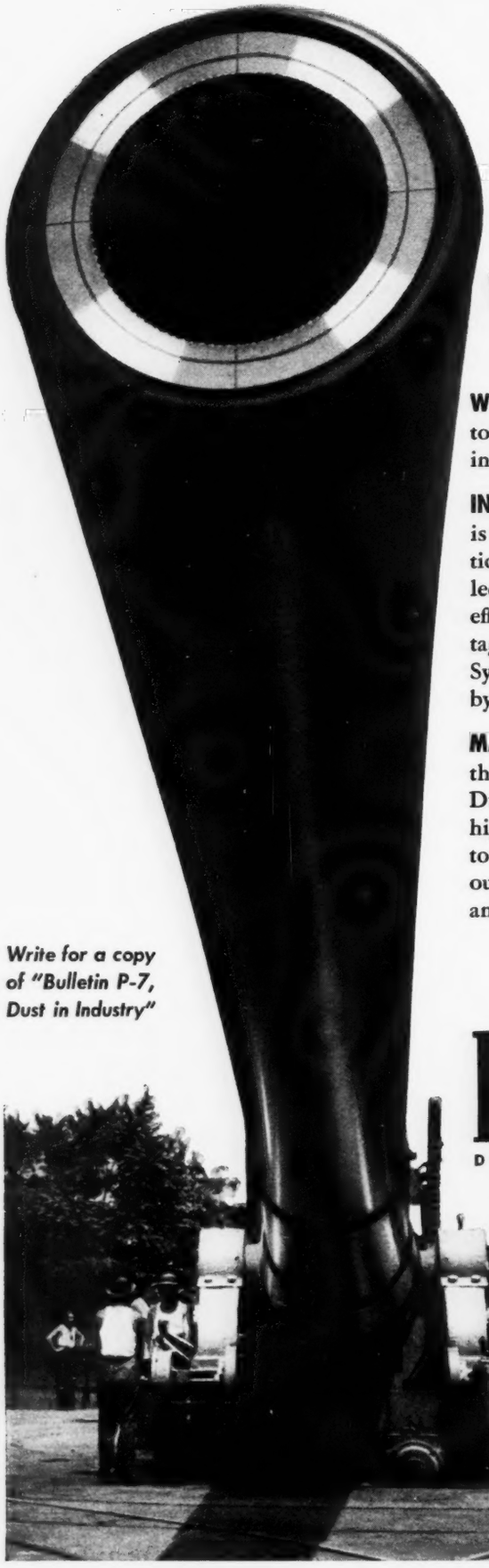

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Safety Practices in Elevator Maintenance

SAFETY AS APPLIED TO ELEVATORS may be divided into safety of those using the elevator and of workmen who maintain the equipment. It is with the latter that we will give our attention. When working in the hoistway the counterweights are always a potential hazard to be guarded against. If the counterweights travel between cars, there is always danger of men working on top of one car, forgetting and stepping into the path of the counterweights on an adjacent car. Fatal accidents have happened from this cause.

Even when the counterweights are at the rear of the hoistway, a workman inspecting some part on top of a car traveling upward may forget himself, get in the way of the descending counterweight and be seriously injured.

On 2-to-1 roped-traction machines there is a sheave in the car crosshead to be religiously avoided when the car is in motion. On direct-traction or drum-type machines the ropes are fixed to the car crosshead. These may be taken hold of to steady oneself when riding on top of the car.

If a workman forgets and catches hold of the ropes when a 2-to-1 roped car is in motion, his hand either goes down toward the sheave with the ropes or goes upward. In the first case there is danger of his hand being caught between the ropes and the sheaves, resulting in the loss of a hand or a more serious injury. In the latter, when the workman's hand moves up it may throw him off his balance and he might be seriously injured by falling against the hoistway wall or parts of the car. Even under the best conditions, the top of an elevator car is a dangerous place to work. Work should not be undertaken here without a very reliable man on guard at the car switch and with the safety switch open.

In the pit under the car there is always the danger of being hit by the counterweights when they descend, particularly when they are located between hoistways. When a compensating-rope sheave is in the pit it is an accident hazard when the car is in motion that should never be overlooked. A workman's hands or loose clothing may be caught between the ropes and sheave.

Where clearance between the bottom of the car and pit is close, be careful that the car is not accidently lowered on the workman when he is inspecting the lower guide shoes and safeties on the bottom of the car, or when cleaning out the pit.

If work is to be done for an hour

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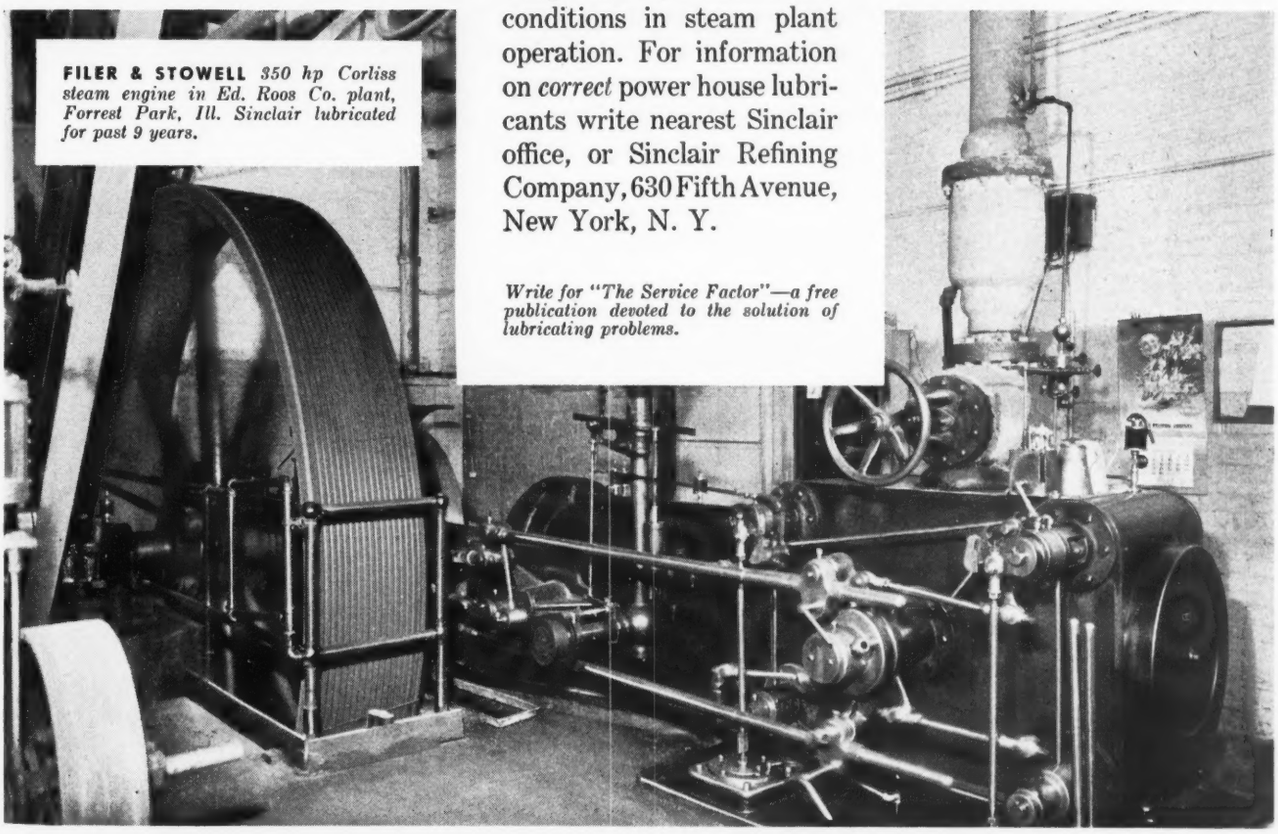

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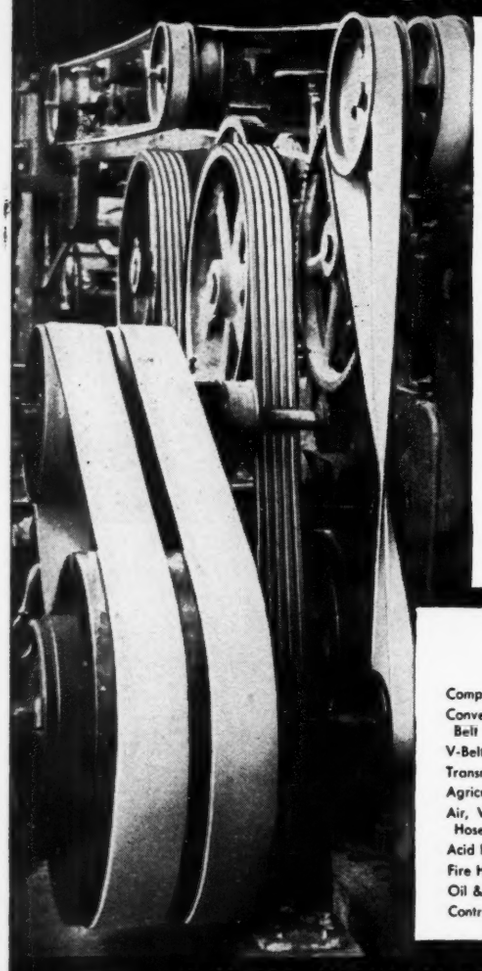

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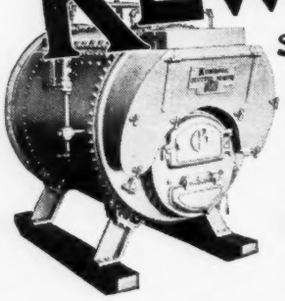

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or more in the pit the main switch should be opened in the elevator power circuit. It is also advisable to block the direction switches open for there is always a possibility of some one in the motor room closing these switches manually. The same precautions apply to the top of the car when the clearance is small between the car and the overhead structure.

In the machine room one of the greatest hazards is that of workmen getting loose clothing caught between the ropes and sheaves or drums. A loose necktie has on more than one occasion caused a fatal accident, by being caught under the ropes on the drum. The victim, in trying to break lose may also get his hands caught under the ropes.

On electrically controlled elevators, when the power switch is open, the entire equipment becomes inoperative. Not so on mechanically controlled elevators, because much of the control equipment can be moved. Thus, there is the possibility of pinched fingers if a mechanic happens to be working around the control when the hand rope is pulled accidently by someone in the car.

On traction elevators, the work of replacing the hoistway ropes is done with the top of the car approximately level with the top floor. To have the car at this level when lifted to slacken the ropes, the counterweights must be supported on vertical timbers from the bottom of the pit. Care must be taken to have these timbers of ample strength to support the counterweights and also placed so that they cannot slip when loaded. To emphasize the importance of this it is only necessary to mention that the counterweights on heavy passenger cars weigh several tons.

The car is lifted by chain falls connected to the overhead steel work and the car sling by wire-rope slings. These must be of ample strength and applied so that they will not be fouled and fail while loaded. When running off the old cables and on the new, make sure that when the rope is free it can always be kept under control. Once a rope gets out of control it will go down the hoistway and may damage equipment, the cable, and cause serious injury to workmen.

Care must also be taken to prevent tools or other objects from falling down the hoistway. When handling the old ropes, workmen should wear heavy gloves as protection against broken wires in the strands. When an old rope is bent sharply the ends of broken wire are likely to spring up and can cause severe hand wounds.